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MANUAL

OF

CONCHOLOGY;

STRUCTURAL AND SYSTEMATIC.

WITH ILLUSTRATIONS OF THE SPECIES.

BY GEORGE W. TRYON, JR.

CONTINUATION BY

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CONSERVATOR OF THE CONCHOLOGICAL SECTION OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA.

Vol. XIV.

POLYPLACOPHORA,

(*Chitons.*)

LEPIDOPLEURIDÆ, ISCHNOCHITONIDÆ, CHITONIDÆ, MOPALIIDÆ.

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"The only possible check to the progress of Science is that the works on it are becoming too voluminous; it is becoming scholastic: life will be too short to learn it, and no time will be left for discoveries."—GROVE.

"The Truth must be told, whoever may be hurt by it. There is no doubt that some writers endeavor to conceal in a fog of mere words the want of clear and well-defined ideas, as well as of that critical knowledge which is indispensable in Natural History; and it is out of this that has arisen that legion of phantoms which so effectually bewilder the inexperienced."—*Anon. Gardener's Chronicle, Dec., 1854.*

52321

PREFACE.

The present volume contains a monograph of the important and extensive Order *Polyplacophora*, commonly known as Chitons. Although represented by many species in all seas, the Chitons have been much neglected by Conchologists. This may be due to the fact that their characters are not generally understood, or even seen in ordinary cabinet specimens; and again, no illustrated work treating the group scientifically has hitherto been produced. Certain it is, that if the serious study of this group be once begun, its attractions will be found to equal or excel those of any other families. The numberless modifications of form, the beautiful adaptation of structure to life-habits and station, the marvelous parallel developments, producing almost identical structures in totally diverse phyla,—all distinguish the *Polyplacophora* as preëminently interesting among mollusks.

The author begs those who may use this work to begin by taking apart one specimen of each species to be studied; then find the genus by the Key on page xxviii. After a certain amount of practice the genus may be ascertained by removing valves vii and viii only; but guessing it from the external features is in most cases uncertain and unscientific. As a rule, Chitons tell no secrets to those who will not take the trouble to disarticulate them.

It is hoped that describers of new species will hereafter state the generic characters of their novelties. It is as rational to describe a bivalve without examining its hinge-teeth, as to notice the outside only of a Chiton.

The synonymy is believed to be practically exhaustive, except that useless references to mere lists giving no new information are omitted.

Attention should here be directed to the new theories of the origin of important structures of shell and girdle, given on pp. ix, xii; to the original system of classification (p. xxiii), and the phylogenies (pp. xxvii, xxviii).

The new species described herein which are credited to *Carpenter* rest upon his types *when the descriptions are quoted from his Ms.* (as in the case of *Callochiton princeps*, p. 50). In cases where I have

given *original* descriptions of new species, whether the specific names be Carpenter's or my own, the types are understood to be *the specimens described by me*, in the collection of the Academy; wherever and whatever the original Carpenterian specimens may be. A case in point is *Ischnochiton acrior*, p. 60, and *I. conspicuus*, p. 63. It is only by this expedient that confusion can be avoided in cases of real or fancied wrong identification, on my part, of Carpenter's *Ms.* species.

Many new species not illustrated in the body of the work are figured from the types in the Appendix. The Appendix should always be consulted when a species is not found elsewhere, as forms of unknown generic position have been included therein.

The grateful task remains of acknowledging assistance from scientific friends and institutions. Through the intervention of Dr. Wm. H. Dall, Honorary Curator of the Department of Mollusks, U. S. National Museum, the writer has received from S. P. Langley, Secretary of the Smithsonian Institution, the drawings and *MS.* prepared by the lamented Philip P. Carpenter upon this group, a work of priceless value, embodying the results of many years study of the subject. Throughout the text of this volume will be found extracts from this *MS.;* such quotations in every case being carefully credited. For the loan of a large number of type specimens from the Smithsonian collections, the writer is indebted to the continued kindness of Dr. Dall. To J. F. Whiteaves of the Canada Geological Survey, Prof. Whitfield of the American Museum of Natural History, New York City, Professor F. W. Hutton of Christchurch, New Zealand, and many other conchologists, the thanks of the author are due for specimens presented or loaned.

H. A. P.

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MANUAL OF CONCHOLOGY.

MONOGRAPH OF THE POLYPLACOPHORA.

Class AMPHINEURA.

Bilaterally symmetrical mollusks, the nervous system consisting of four (two lateral and two ventral or pedal) parallel cords, meeting in a cerebral ganglion; other ganglia feebly or not developed. Anus posterior and median; head without tentacles or eyes.

The *Amphineura* or *Isopleura* constitute one of the five primary divisions or *Classes* into which the Mollusk phylum divides; and it is, in many respects, the most primitive of all. This class has been by most authors considered a sub-class or order of *Gastropoda;* but the fact should be distinctly recognized that the characters common to *Gastropoda* and *Amphineura* are either features possessed by the (hypothetical) primitive mollusk, or are peculiarities evolved in response to similar habits of life. The *Patellidæ* among Gastropoda have been repeatedly compared to the Amphineurous family *Chitonidæ;* but the branchial cordon of *Patella* is in no way homologous with the gills (or ctenidia) of *Chiton,* and the nervous and digestive systems are profoundly different.

The class *Amphineura* is divisible into two Orders:

Order I. POLYPLACOPHORA. Dorsal surface bearing eight imbricating shelly plates; head divided from the body; gills numerous, occupying a lateral groove on each side between the foot and the encircling mantle; foot adapted to creeping; genital organs and nephridia paired; sexes distinct; radula well developed.

Order II. APLACOPHORA. Body subcylindrical or vermiform, without shelly plates or valves; foot rudimentary or aborted, the mantle cavity being reduced to a ventral groove terminating in a posterior cloaca containing the rudimentary gills, and the outlets of anus and nephridia.

Order POLYPLACOPHORA Blainville.

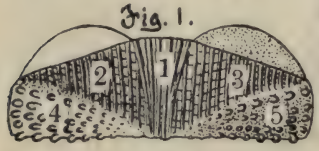
The further division of this order into families and genera will be found on page xxiv.

The following notes on the morphology of Chitons are mainly restricted to features important from a phylogenetic or taxonomic standpoint; the primary object of this work being, of course, the establishment of a natural system of the Order.

The Shell.

The shell in Chitons consists of eight imbricating pieces or *valves*, bound together by a leathery *girdle* of connective tissue. The valves, when freed of the girdle by soaking a few hours in water, are seen to be of three forms: the *anterior*, (or "head valve") semicircular in outline its apex elevated; the *intermediate* (sometimes called "central" or "median") valves, squarish in shape, and the *posterior* or "tail valve," which is like the intermediate valves with the addition of a sloping surface behind the apex or *mucro*. *In structure, the valves are composed of two layers, generally quite different in color and texture; an outer layer, called by Middendorff the* tegmentum, *and an inner, the* articulamentum.

The surface of the valves (*tegmentum*) is divided in nearly all Chitons into clearly defined or indistinct areas. The intermediate valves (fig. 1) are divided into *lateral areas* and a *central area;* the latter being subdivided into a *dorsal* or *jugal tract*, extending along the ridge of the valve, and two *pleura* or *pleural tracts*, occupying the side-slopes in front of the *diagonal line* or *rib*. In some forms (fig. 2) the diagonal line is obliterated, the lateral areas and the pleural tracts being united into a single uniformly sculptured expanse, the *latero-pleural area*, on each side; the dorsal or jugal area remaining distinct. This modification is characteristic of one great phylum of Chitons. As a rule the head-valve is sculptured all over like the lateral areas. The posterior valve (fig. 4) is divided into a *central* and a *posterior* area; the former being precisely similar to the area so named in the intermediate valves



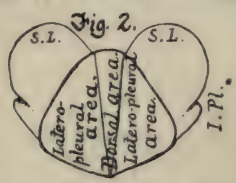


Fig. 1. Intermediate (fourth) valve of *Ischnochiton mertensii*, 1, 2, 3, central area (subdivided into 1 jugal tract, and 2, 3, pleural tracts); 4, 5, lateral areas.

Fig. 2. Intermediate valve of *Acanthochites defilippii*, showing *I. Pl.*, insertion plate, and *S. L.*, sutural laminæ.

and the latter corresponding closely in sculpture to the lateral areas. In some genera the mucro is near or at the posterior edge of the valve, and the posterior area is then reduced to a narrow tract, or altogether absent (see pl. 52, figs. 17, 18). In position, the mucro may be either *anterior* (pl. 30, fig. 23), or *median* (pl. 17, fig. 22) or *posterior* (pl. 52, figs. 22, 23); and it may be either elevated (pl. 36, fig. 94), or depressed (pl. 39, fig. 41), the last being sometimes called a flat or planate mucro.

THE INNER LAYER OF THE VALVES (*articulamentum*) is larger than the tegmentum, projecting in front in two lobes called *sutural laminæ*, which are separated by a median bay, the *jugal sinus*. At the sides of the intermediate valves, and around the semicircle of the end valves, most Chitons have projecting plates called *insertion plates*, to which the girdle is attached. These are commonly cut into *teeth* by transverse *slits*. From the slits to the apex of each valve inside, run slight grooves and rows of pores, known as *slit-rays;* often they are obliterated, but in forms having a highly developed system of sense-organs in the tegmentum, the pores of the slit-rays serve as nerve foramina. The teeth are sometimes finely cut or crenulated, (technically "pectinated") between the slits; and in some forms the edges of the teeth are thickened outside, or "propped." Fig. 3 represents the interior of the fourth valve of an *Ischnochiton*, showing the slits, teeth, insertion plates, etc.

Figs. 3, 4. Intermediate and posterior valves of *Ischnochiton conspicuus*.

The tegmentum is essentially cuticular in nature. It consists of a chitinous foundation substance, impregnated with salts of lime. It is perforated at the surface by a multitude of minute, definitely arranged pores of two sizes, called by Moseley, the larger *megalopores*, the smaller *micropores* (see pl. 52, fig. 28, showing two megalopores and many micropores). Each megalopore leads into a cylindrical chamber which is continued below into a wide canal, which as it penetrates deeper toward the plane of junction of tegmentum and articulamentum, curves outward toward the girdle-margin of the former. On reaching the plane of junction it joins a plexus of wide

main canals which ramify horizontally in this plane, and find opening from the valves at the *eaves*, or outer bases of the teeth and anterior sinus. From the sides of the megalopore chambers or from the deeper plexus of canals, are given off fine canals which perforate the tegmentum vertically and join the bases of the micropore cavities. All of these canals are occupied by fibrous and nerve tissues continued in from the girdle and interior. From these ramifications are given off branches to each megalopore canal, in the superficial chamber of which they expand into obconic knobs of highly refracting tissue, sensory in function, and in all probability tactile. These knobs are called by Moseley, *megalæsthetes;* they are capable of being somewhat protruded from the mouths of the pores. The micropores hold exactly similar but smaller sense-organs, the *micræsthetes*. These structures are found in probably all Chitons; but in certain genera they are subobsolete. In others some of the megalæsthetes have become transformed into *eyes*. These are connected with the network of soft tissues, and occupy pear-shaped cavities like the true megalæsthetes. On one side the bulb of the pear, more or less near its extremity, is closely applied to the outer surface of the tegmentum, and here its wall is pierced by a circular aperture, the pupil-like opening. This opening covered by the cornea, the periphery of which extends to a considerable distance beyond its margin all round.

The cornea is a concavo-convex, watch glass-shaped lamina, transparent, and calcareous in structure, being continuous all around with the superficial calcareous layer of the tegmentum. "The pear-shaped cavity of the eye in the tegmentum is lined by a dark brown pigmented membrane of a stiff and apparently somewhat chitinous texture, which forms the eye capsule. This capsular membrane exactly follows the shape of the eye cavity, except near the surface of the tegmentum, where its margin curves inward beneath the cornea, forming a sort of iris and bounding the circular pupil, which is of less diameter than the cornea. The aperture of the pupil is occupied by the front surface of the lens. The lens is perfectly transparent and hyaline, and strongly biconvex. It is filled in behind the iris aperture. It is composed of soft tissue and dissolves in strong acetic acid gradually and completely, showing a fibrous distinct structure in the process. There is a space between the front surface of the lens and the cornea.

"Within the pigmented tubular prolongation of the eye capsule

the numerous fine fibres composing the optic nerve become separated from one another and loose. Immediately underneath the retina the fibres become still more widely separated, forming an expansion of fibres. The retina is formed on the type of that of *Helix*, and not, as might have been expected, on that of the dorsal eyes of *Onchidium* or the eyes of *Pecten*. The fibres of the optic nerve do not pass in front of the layer of rods to be distributed to them from in front, but are directed to the rods directly from behind. The retina presents a single layer of short but extremely well defined rods, the extremities of which are directed toward the light. The rods when viewed from the surface of the layer they compose are seen to be hexagonal or pentagonal in outline, and each contains a nucleus. They form a layer which is concave toward the lens, there being a space between the hind surface of the lens and the concave face of the layer."

Two eyes from the shell of *Enoplochiton* (x 40) are shown on pl. 52, fig. 27. On pl. 51, fig. 3 is seen an eye of *Schizochiton* magnified 200 diameters, showing outside the pigmented eye-capsule, seen partly through the superficial layers of the tegmentum, inside of which is the cornea, and the lens, seen through the cornea.

The arrangement of the eyes varies in different genera, as will be seen by reference to the systematic descriptions. Eyes are present in but one family of Chitons, the *Chitonidæ;* and in this group they are found in all but two genera. In these two the megalæsthetes are larger and more regularly developed than in any Chitons of other families. This high development of sense organs is associated with the most complex system of insertion-plates, the completest form of girdle-armor and of gills to be found in the Polyplacophora. The family *Chitonidæ* therefore, easily ranks as the consummation of Chiton development. *Tonicia* or *Acanthopleura* represent the utmost height yet attained by the great Amphineurous branch of mollusk life.

Theory of the origin of valve-structures. Any rational theory of the development of a structure must rest upon a knowledge of the relations of that structure to the organism possessing it and to the external world. In discussing the genesis of the insertion-plates of Chitons we must therefore bear in mind (1) that the function of these plates is to bind the valves firmly to the girdle, and (2) that the entire force of all impacts on the valves is transmitted *to these plates*, which are separated from the solid surface supporting the

animal by a thin pad of girdle. It is to the direct effect of impacts and strains continually brought to bear upon the growing edges of these plates, that their development is due, in precisely the same manner that the enlarged joints of a laborer's hand are the result of the impacts and strains to which they have been subjected. All Chitons which live in situations exposed to the buffeting of the surf, possess highly-developed insertion-plates, which are, moreover, in nearly every cases, conspicuously corrugated for the more effective grasp of the girdle. Examples are the groups *Enoplochiton* and *Mesotomura* on the west coast of South America, *Acanthopleura* in the West Indies and elsewhere, *Liolophura* in Australia and Japan, all remarkable for the great development of strong, rough insertion plates, and equally for the very exposed situations in which they live, often subjected to the full force of the surf. It is, of course, the belief of the writer that characters acquired by the action of natural forces, acting upon many generations, become hereditary; but in this case "natural selection" no doubt has had a certain considerable effect, although the process has, I believe, been mainly one of selection from definite variations produced by the mechanical causes described above, not selection from indefinite variations in all directions.

On the other hand, forms living in less exposed stations, such as beneath stones at or below low water, have thin, smooth insertion plates (*Ischnochiton*, etc); and at great depths, where the motion of the water and its power of transporting pebbles or stones is reduced to a minimum, and where therefore the valves of the Chitons are not subject to impacts or strains from without, the species are found to be entirely without insertion plates. This excessively weak organization has been transmitted unchanged from the Palæozoic Chitons, all of which lacked insertion-plates; and it is a significant fact that this antique type has been able to exist to the present time only in deep water, where the forces which I believe to have moulded the modern Chitons do not act, and where competition in the life-struggle is less severe than in the shallows.

In this connection the case of *Plaxiphora* (*Placophoropsis*) *atlantica* should be cited. This species was dredged off New England in 122 to 640 fms.,—depths beyond the limit of the penetration of light, and of course far beyond the reach of appreciable water movement, either by currents or surface disturbances. The conditions therefore demand no stronger apparatus for the attachment of the valves to

the girdle than is possessed by *Lepidopleurus;* and in fact we find that its insertion plates are reduced to very short stumps. The anterior "teeth" are small, low, unevenly notched, and not nearly as long as the overhanging eaves. It is only necessary to point out that the genus *Plaxiphora*, the nearest ally of *Placophoropsis*, is remarkable for the length of its strong, regularly slit insertion plates. The same is true of the entire family *Mopaliidæ*, to which these genera belong. In *Placophoropsis atlantica* we have, therefore, a member of a family of littoral Chitons, which by descent into the abyssal region has partially lost by retrogressive development through disuse the characters originally evolved to fit the ancestral forms for existence in the littoral zone. Further deep sea researches will probably reveal other cases of degeneration along the lines here indicated; and it is not impossible that forms as destitute of insertion plates as the genus *Lepidopleurus* have been produced from higher types by retrogessive evolution; but there is at present no evidence of the existence of such forms.

The Girdle.

This organ variously called ligament, zone, or girdle, is a band of connective and muscular tissues extending around the valves, the edges of which are imbedded in it. The surface of the girdle is variously clothed with scales, spines, hairs or spicules, or is naked. The armor, whether of spines, scales or hairs, consists of a chitinous foundation more or less infiltrated with lime. The girdle-appendages vary greatly in development among closely allied species; but the general type of covering is a moderately constant generic character. In some forms the girdle encroaches upon or entirely covers the valves. In some genera having a posterior sinus in the tail-valve, the girdle has a corresponding sinus or slit; in others it has no sinus, but in life is always curved upward into a posterior conduit, serving for an outlet for the anus and gills.

In some forms having hairy or spiculose girdles, the hairs or spicules are gathered into tufts or groups at the sutures (*i. e.* lateral points of junction between valves), and around the anterior valve; issuing from pits or *pores* at those places (see pl. 5, fig. 97). In their incipient stage, these sutural tufts are merely the gathering together of two or several of the ordinary surface hairs; in their full development they are dense clusters of long spicules; and in their decadence only a small pit or pore remains. The presence of

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pores or tufts has been considered by systematists a character of great value; but not with justice. The fact is that at least three times in the development of Chitons has this feature appeared independently; first in the genus *Hemiarthrum* of *Lepidopleuridæ*, this form having a pore at each suture, and *six* around the head valve; second in *Callistoplacinæ* (culminating in *Mopaliidæ*) where the pores are excessively inconstant, and the number around the head valve indefinite (0–6); and for the third time in *Acanthochitidæ* and its derivative *Cryptoplacidæ*, where the number of tufts around the head valve is invariably four, in genera having pores. Every genus (if it has more than one or two species) containing pore-bearing species, includes also forms in which the pores or tufts have become subobsolete or entirely lost. In the genera of *Mopaliidæ*, the pores are occasionally not of specific importance; and the same is true of *Amicula*.

The genesis of sutural tufts is not beyond the reach of theory. I believe them to be the direct result of over-nutrition of the girdle at the sutures, caused by its greater mobility at those points. It is obvious that every motion of the valves must cause a flexure of the girdle at the sutures; this brings a greater flow of nutriment to the stimulated portion, in this case a narrow strip, resulting in a more exuberant growth there.

Head, Foot, Gills, etc.

Viewed ventrally Chiton presents a fleshy foot, similar to that of the *Gastropoda* (pl. 34, fig. 68). Separated from this by a sinus is the head, with the mouth in the center of the disk, which is generally surrounded in front by a lappet called by Carpenter the "veil." There are no tentacles or eyes. The inner edge of the ventral surface of the girdle may be regarded as the mantle. It is sometimes fringed or produced into finger-shaped processes in front. The gills consist of a row of triangular branchial plumes extending from near the tail forward from a fourth to the entire length of the foot. The anus is median and posterior, generally opening on a papilla. The two nephridial openings are in the gill-groove, at the side and in front of the anus. The two genital openings are in front of the nephridial orifices.

The radula has been investigated by Lovén, Sars, and especially by Dall, who describes the teeth as follows: "In all Chitons examined there is a simply cuspid rhachidian tooth, and on each side a

translucent minor lateral of varying form; a major lateral larger than any of the other teeth, with a conspicuous black cusp, which may have from one to four denticles; two boss-like or thickened uncinal plates of irregular shape; a twisted spatulate uncinal, and three scale-like or slightly thickened external uncini. With the exception of the spatulate uncinus (which is aborted in a very few species) none of the uncini are much raised above the plane of the odontophore, and none present any characters of importance."

Dall has figured and described the dentition of species belonging to over half of the genera and subgenera recognized by Carpenter including all of the main types. He concludes that as yet no characters affording grounds for even generic distinctions can be found in the teeth, which exhibit a most surprising uniformity throughout the entire group. The dentition of a number of genera not examined by Dr. Dall has been worked out by the writer, but without result as far as the discovery of structures of taxonomic value is concerned. It is evident that while some minor features of the dentition are characteristic of groups founded upon other characters, we need expect little assistance in larger questions of group affinities from the further investigation of this organ.

The gills are "posterior" or short in the lower Chitons, the *Lepidopleuridæ*, and also in the lowest *Ischnochitonidæ*, and in most genera of the phylum *Acanthochitidæ—Cryptoplacidæ*, which arose from an early Ischnoid stock. All other Chitons, including the higher *Ischnochitonidæ*, the *Mopaliidæ* and the *Chitonidæ*, have "ambient" or long gills.

Teratology.

The occurrence of six- and seven-valved Chitons has been noted as early as the time of Linnæus. It is likely that the six-valved were artificial fabrications, although a certain number may perhaps be traced to incorrect drawings. Most seven-valved specimens are due to the soldering together of two valves in consequence of some injury. This is not uncommon, a number of cases having come under my observation. Individuals actually seven-valved are known to occur, although they are far from common. The writer has examined many thousand Chitons, but has seen only two normally 7-valved examples. One of these is figured on pl. 64, fig. 67; and as may be seen, it is in no respect abnormal save in the want of one central valve, and the consequent lengthening of the others. There is absolutely no trace

of the missing valve. The absence of a valve produces no striking change in the general appearance of the animal, and it would be easy to pass one by among a quantity. These considerations incline me to think that abnormalities in the valves may be less rare than supposed.

Injuries to the girdle often produce more or less irregular growth. In species having large girdle-scales, such as Chiton *s. str.*, or the large-scaled *Ischnochitons*, the loss of scales is repaired by the growth over the injured area of scales much smaller in size, giving it a singularly patched appearance.

Collection and Preservation of Chitons.

Chitons may be looked for on all but sandy coasts; on these they are very rare. Some species, like *Nuttallina*, *Enoplochiton*, *Acanthopleura*, etc., are found upon the exposed rocks at or near high tide; others like most *Ischnochitons*, live under stones between tides or at lowest water; but it is only by the use of the dredge that any approach to a full representation of the Chiton fauna of any locality can be obtained. No elaborate dredging outfit is required, however, for over nine-tenths of the species being vegetable eaters, live in the littoral (including the laminarian and coralline) zone, and may generally be taken in 25 fms. or less depth; although numbers of species extend their range to or beyond the 100 fm. line, and a few (the genera *Lepidopleurus* and *Hanleya* only) live in the cold and dark abyssal region.

A blunt knife is useful to the collector in detaching Chitons from the rocks etc.; and the specimens before they have time to curl themselves up, should be placed flat on a narrow strip of smooth wood like a ruler or lath well wetted with salt water, and bound down by winding with soft twine or candle-wicking. This will keep them in a natural position until the tissues are relaxed, when they may be placed in alcohol, or cleaned by cutting away the foot and viscera. If this precaution is not taken they are apt to curl up in a shape which renders them almost useless for dissection or for cabinet specimens, for they will break rather than flatten out. A large number may be thus set on a single stick. If they curl up before they can be set, it is best to put them in a pan of salt water, where they will eventually straighten out, if alive.

Historical Notes on the Literature of Chitons.

Very few species of Chitons were known to writers upon shells

prior to 1758, the date of Linnæus' Tenth Edition, in which four species were described. By the addition of the forms of northern Europe, this number is increased to nine in the twelfth edition of the *Systema*. From this time on, large numbers of Chitons found their way into English and Continental collections, and were figured in the works of Chemnitz and others. Linné classed the Chitons with the Cirripeds and Pholads, before the bivalves; and this system persisted in conservative conchological works during the first few decades of the present century. In 1797, Spengler, a Danish naturalist, published a good monograph upon Chiton; but little real progress was made toward a right appreciation of the rank of the group, and the establishment of a natural classification, until Blainville in 1816 (Bull. Philom.) separated them from the other mollusks as a Class, to which he gave the name *Polyplaxiphora*. In 1825, Blainville published the article upon Chitons in the *Dictionaire des Sciences Naturelles*. In this work an excellent description of the entire organization is given, the parts of the valves are definitely named, and the characters upon which the divisions of the genus must be based are stated. The extraordinary insight and genius of the French malacologist are manifest throughout the systematic and structural part of this paper; but the descriptions of species, being unaccompanied by illustrations, have been less useful. Quoy & Gaimard, in 1834, gave an excellent account of the species collected during the voyage of the 'Astrolabe'; following the general lines laid down by de Blainville. Since 1834, no systematic work on Chitons of more than local interest, has been published upon the continent of Europe.

In England, considerable species-work upon Chitons was done prior to 1829, but all upon strictly Linnæan lines. In the year 1829, Rev. Lansdown Guilding, residing in St. Vincent, West Indies, wrote a valuable paper, in which he recognized five genera: *Chiton, Acanthopleura, Phakellopleura, Chitonellus, Cryptoconchus;* defining each in an acceptable manner. Shortly after this, the discoveries of Frembly, Cuming and others, threw a multitude of new and handsome species into the hands of the London conchologists. Broderip and Sowerby described most of these novelities in the P. Z. S., 1832–1834, and in the Mag. of Nat. Hist., 1840; and Sowerby illustrated them in the *Conchological Illustrations*, published a little later. These authors knew nothing of internal characters, confining their attention to the superficial features of the shell only.

The same is true of REEVE, who in 1847, published a monograph containing 189 species in the *Conchologia Iconica*. The figures of Sowerby and Reeve are generally good; but they ignore internal characters, and their descriptions are totally inadequate. J. E. GRAY, in 1847, (Ann. Mag. Nat. Hist., July–August, and P. Z. S.), proposed a system of classification of *Chitonidæ*, embracing many new genera, but largely based upon Blainville's article of 1825. Gray's system is as follows:

I. Mantle simple, without any pores or tufts of spines on the sides.

A. The plate of insertion of the anterior and posterior valves divided into several lobes, and of the central valves into two lobes.

a. Containing Chiton, Tonicia, Acanthopleura, Schizochiton.

b. Containing Corephium, Plaxiphora, Onithochiton, Enoplochiton.

[*c.* Radsia, Callochiton, Ischnochiton, Leptochiton, subsequently added by Gray.]

B. The plate of insertion of all the valves with only a single notch on each side. The valves more or less covered; the hinder valve with expanded plates of insertion (as in the central valves), with only a single notch on each side, and a concave sinuosity below.

a. Contains Mopalia, Katharina, Cryptochiton.

II. Mantle with a series of pores (each furnished with a tuft of spines) on each side. The plates of insertion of all the valves with only a single notch on each side which is sometimes rudimentary.

a. Contains Cryptoconchus, Amicula, Acanthochites, Chitonellus.

Some inconsiderable transpositions and additions were made by Gray in his *Guide*, 1857. This classification is accepted by H. & A. Adams, in their *Genera of Recent Mollusca*, 1858; the two primary divisions being regarded as subfamilies (*Chitoninæ* and *Cryptoplacinæ*) by them. The species of their lists in very many cases do not belong to the genera to which they are assigned, the lists having been compiled without regard to the characters of the insertion plates. The main defects of this system are the greatly exaggerated importance given to the development of girdle-pores, and the imperfect apprehension of the features of the insertion plates. Some years before the date of Gray's last paper, J. R. SHUTTLEWORTH, an Englishman by birth, but resident in Switzerland, studied the Chitons carefully in the light of Gray's earlier paper, and published a well-digested synopsis of the group (Bern. Mittheil, 1853), making a number of decided improvements in classification.

At the same time that Gray published his first essay, Dr. A. Th. von Middendorff proposed an elaborate scheme of classification, in an extensive work upon the Siberian Chitons. His divisions were based upon (1) the entirely internal or partly exposed condition of the valves, and position of the apex of each, (2) degree of immersion, indicated by the contiguity or separation of the exposed part of the valves, (3) comparative width of the girdle, and (4) presence or absence of girdle-pores. This classification although worked out with vast industry, is a distinct retrogression from the stand taken by de Blainville in 1825. Middendorff however, did excellent work upon the anatomy of the Chitons in this publication. His arrangement is as follows:

Genus *Chiton* L.

(1) Subgenus *Cryptochiton* Midd. (C. stelleri).

(1) Subgenus *Phœnochiton* Midd.

(2) Section *Dichachiton* Midd.

(3) Subsection *Symmetrogephyrus* Midd.

(*a.*) Poriferi, Ch. (Symmetr.) monticularis Q. [=Cryptoconchus.]

(*b.*) Apori, Ch. (Symmetr.) vestitus, pallasi, amiculatus [=Amicula.]

(3) Subsection *Ametrogephyrus* Midd.

(*a.*) Poriferi, Ch. fasciatus Q., larvæformis Blv. [=Cryptoplax.]

(*b.*) Apori, Ch. lævis Lm. [=Cryptoplax.]

(2) Section *Hamachiton* Midd.

(3) Subsection *Platysemus* Midd.

(*a.*) Poriferi, Ch. zelandicus, emersoni, biramosus, etc., [=Acanthochites, Plaxiphora, etc.]

(*b.*) Apori, Ch. submarmoreus, tunicatus, alatus, incisus, wosnessenskii, [=Tonicella, Katharina, Ischnochiton, Mopalia, etc.]

(3) Subsection *Stenosemus* Midd.

(*a.*) Girdle hairy, Ch. marmoreus, lineatus, brandti, mercki, etc., [=Tonicella, Schizoplax, etc.]

(*b.*) Girdle finely squamose, Ch. ruber, albus, cinereus, etc., [=Trachydermon, Lepidopleurus.]

(*c.*) Girdle coarsely scaly, Ch. mertensii, etc., [=Lepidozona.]

Middendorff's names being published simultaneously with Gray's,

cannot be given priority, save in the case of Cryptochiton; the other groups are all incongrous assemblages.

From this time, no work of importance was done on Chitons until 1863, when PHILIP P. CARPENTER (born in Bristol, England, in 1819, died at Montreal, Canada, 1877) published a catalogue of the West American forms (Brit. Asso. Rep). This was followed by many articles upon the Californian and Atlantic Chitons, and finally by the preparation of a monograph of the entire group. In his work upon this great undertaking, Dr. Carpenter examined critically the Cumingian and British Museum collections, containing most of the types of Broderip, Sowerby, Gray, Reeve and H. Adams; and besides, nearly every collection of any size in England and America, including those of A. Adams, Angas, Dr. A. A. Gould, Newcomb, Jay, Haines, the State of California, the Smithsonian Institution, Museum of Comparative Zoology, etc. The information gained from the examination of this great amount of material was in process of re-arrangement at the time of his death, in 1877, that relating to the *Leptoidea* and *Ischnoidea* being practically completed. A vast amount of work had been done upon the other groups, but his studies of them were far from finished. A large number of drawings had been prepared under Dr. Carpenter's direction, mainly by Messrs Emerton, Foord, and Smith. The whole of this *MS.* being devised to the Smithsonian Institution, Dr. WM. H. DALL published (Proc. U. S. Nat. Mus. 1881, p. 283–292) an *Abstract of all the genera* of Chitons, giving Carpenter's complete classification, and brief diagnosis of the new groups. Most of the Carpenterian names therefore date from this time; although in 1873 a large part of them were included by Carpenter in a table printed by the Smithsonian Institution, showing the characters of the "Regular Chitons." The fact that the distribution of this table was limited to Carpenter's personal friends and correspondents, that it was never advertised or offered for sale, was not sent to most (if any) public scientific libraries nor noticed in scientific journals, prevents us from dating his names from the time of its publication.

The following table shows the Carpenterian classification in full. The group and family names given by DALL in 1889 ('Blake" Gastropoda) are added in parenthesis.

Order POLYPLACIPHORA (*Polyplacophora* Dall).

Section I.—Chitones regulares (EOCHITONIA Dall).

Head and tail plates similarly articulated.

A. LEPTOIDEA (*Leptochitonidæ* Dall)

Insertion plates obsolete or, if present, unslit.

(*Extinct forms.*)

Helminthochiton Salter.
Gryphochiton Gray.
  Chonechiton Cpr.
Priscochiton Billings.
Pterochiton Cpr.
  ? Loricites Cpr.
Probolæum Cpr.
Cymatochiton Dall.

(*Recent forms.*)

Leptochiton Gray.
  Deshayesiella Cpr.
Hanleyia Gray.
Hemiarthrum Cpr.
Microplax Adams and Angas.

B. ISCHNOIDEA (Ischnochitonidæ Dall).

Insertion plates sharp, smooth, fissured; with eaves.

*No pores on girdle.

Trachydermon Cpr.
  Trachyradsia Cpr.
Callochiton Gray.
  Stereochiton Cpr.
Tonicella Cpr.
Schizoplax Dall.
Leptoplax Cpr.
Chætopleura Shuttleworth.
  Maugerella Cpr.
Spongiochiton Cpr.
Ischnochiton Gray.
  Stenoplax Cpr.
  Stenoradsia Cpr.
  Ischnoplax Cpr.
  Heterozona Cpr.
  Ischnochiton s. s. Cpr.
  Ischnoradsia Shuttleworth.
  Lepidopleurus Cpr.
  Lepidoradsia Cpr.
Callistochiton Cpr.

**With girdlepores.

Callistoplax Cpr.
Angasia Cpr.
Newcombia Cpr.
Ceratozona Dall.
Pallochiton Dall.

C. LOPHYROIDEA (*Lophyridæ* Dall).

Insertion plates broad, pectinated, projecting backward.

Chiton Linné.
  Radsia Gray.
Tonicia Gray.
  Fannettia Dall.
Eudoxochiton Shuttleworth.
Craspedochiton Shuttleworth.

D. ACANTHOIDEA (*Acanthopleuridæ* Dall).

Insertion plates thrown forward.

*Plates broad, pectinated (*A. lophyroidea*).

Sclerochiton Cpr.

**Plates sharp, grooved outside (*A. typica*).

Acanthopleura Guilding.
  Lucilina Dall.
Corephium Gray.
Francisia Cpr.

***Plates sharp, smooth (*A. ischnoidea*).

Dinoplax Cpr.
Middendorfia Cpr.
Beanella Dall.
Nuttallina Cpr.
Arthuria Cpr.
Phacellopleura Guilding.

Section II.—Chitones irregulares (Opsichitonia Dall).

Tail plate abnormal or with a sinus behind.

E. Schizoidea (*Schizochitonidæ* Dall).

Tail valve fissured.

Lorica H. and A. Adams.
Schizochiton Gray.
Aulacochiton (Shuttleworth) Cpr.

F. Placiphoroidea (*Placophoridæ* Dall).

Tail valve unslit, internally ridged, mucro nearly terminal.

Enoplochiton Gray.
Ornithochiton Gray.
Placiphora Gray.
Fremblya H. Adams.
Euplaciphora Shuttleworth.
Guildingia Cpr.

G. Mopaloidea (*Mopaliidæ* Dall).

Tail valve with posterior sinus and one slit on each side.

Mopalia Gray.
Placiphorella Cpr.
Katherina Gray.
Acanthochiton (Leach) Herrm.
Macandrellus Cpr.
Stectoplax Cpr.
Notoplax H. Adams.

H. Cryptoidea (*Amiculidæ* Dall).

With double sutural laminæ.

Cryptoconchus Blainville.
Amicula Gray.
Amicula s. s. Dall.
Chlamydochiton Dall.
Cryptochiton Gray & Middendorf.

I. Chitonelloidea (*Cryptoplacidæ* Dall).

Tail plate funnel-shaped. Laminæ thrown forward.

Chitonellus Blainville.
Cryptoplax Gray.
Choneplax Cpr.
Chitoniscus Cpr.

There can be no doubt that Carpenter's classification is a great advance upon that of Gray. It will be noticed that the primary division of the family is into two great groups: (1) Chitons having the head and tail valves similarly articulated with the girdle, and (2) those having them strongly dissimilar. These two great groups were early recognized by Carpenter, and called respectively *Regular* and *Irregular* Chitons.

Dall, in his *Report on the Chitons of Alaska* (1878), accepts the Carpenterian classification, correcting it in some details, notably in the arrangement of the Amiculoid forms. In the same year he published an extensive and extremely valuable paper upon the den-

tition of the group, giving figures and descriptions of the radulæ of species representing a majority of the genera of Chitons. In 1889, Dall proposed the superfamily and family names quoted in parenthesis in the above table.

The writer proposes to show in the course of this work, that the primary division into Regular and Irregular forms is not fundamental, the Irregular group being polyphyletic, consisting of genera derived from several totally distinct stocks. With the exception of the *Leptoidea* (Leptochitonidæ), *Ischnoidea* (Ischnochitonidæ) and *Chitonelloidea* (Cryptoplacidæ), all of the family groups of Carpenter and Dall require dismemberment.

Dr. Paul Fischer, in his Manuel de Conchyliologie, 1885, adopts the Carpenterian arrangement, with some transpositions, but reduces the generic names of former authors to the rank of subgenera and sections. His scheme is as follows. The Carpenterian equivalents being given in brackets, a glance at the above table will show what groups were included by Fischer.

Family Chitonidæ.

Genus Holochiton Fischer, 1885 [=*Leptoidea* Cpr.]

Subgenus *Eochiton* Fischer, 1885 [=Palaeozoic Leptoidea].

Genus Chiton Linn. [Includes *Ischnoidea, Lophyroidea, Acanthoidea* of Cpr.].

Subgenus *Tomochiton* Fischer, 1885 [Includes the *Ischnoidea* and *Acanthoidea ischnoidea* which lack girdle pores].

Subgenus *Porochiton* Fischer, 1885 [Includes the *Ischnoidea* and *Acanthoidea ischnoidea* which have girdle pores].

Subgenus *Chiton s. s.* [=*Lophyroidea* of Cpr.].

Subgenus *Acanthopleura* Guild. [=*Acanthoidea typica* Cpr.].

Genus Anisochiton Fischer, 1885 [Includes *Schizoidea, Placiphoroidea, Mopaloidea* of Cpr.].

Genus Chitonellus Lam. 1819 [=*Chitonelloidea* Cpr.].

Genus Diarthrochiton Fischer, 1885 [=*Cryptoidea* Cpr.].

It will be noticed that Fischer ignores the law of priority in the use of generic names. His classification is not otherwise very different from Carpenter's, except that he reduces the genera of Gray and Carpenter to the rank of sections.

M. A. T. de Rochebrune, in several papers upon Chitons, published from 1881 to 1889, has classified the group in various ways, the principal schemes being given below. It is necessary to give in brackets the equivalents of Rochebrune's genera, in order to under-

stand what his family groups really mean.

In *Nouv. Archives du Muséum* (2) iv, 1881, Rochebrune presents the following arrangement:

Family ACANTHOCHITÆ Rochebr., genus *Acanthochites* Risso.

Family CHÆTOPLEURÆ Rochebr., genus *Chætopleura* Shutt., species *gigas* Chem.; and genus *Acanthopleura* Guild.

Family CHITONIDÆ Gray, genus *Tonicia* Gray, *Lepidopleurus* "Risso" [=Ischnochiton], and genus *Gymnoplax* Gray [=Chiton *s. str.*].

In the *Zool. Cap Horn*, 1889, the following scheme is given:

Family PROCHITONIDÆ, genus *Schizochiton* Gray.

Family LOPHYOCHITONIDÆ, genus *Acanthochiton* Leach.

Family CHÆTOCHITONIDÆ, genus *Acanthopleura* Guild.; genus *Chætopleura* Shutt. [=Plaxiphora + Chætopleura].

Family CHITONIDÆ, genus *Tonicia* Gray; genus *Lepidopleurus* "Carpenter, 1879" [=Ischnochiton + Trachydermon + Callochiton!]; genus *Chiton* L. [=Ischnochiton + Chiton *s. str.*].

It will be seen that the ideas of Rochebrune are so opposed to those of the Carpenter and the writer that any criticism of them would be useless. The same Parisian author has published many diagnoses of Chitons believed to be new; but owing to his failure to mention the characters really diagnostic of genera and species, but little use can be made of his writings. The majority of these forms are still unfigured; and of his figured forms it must be said that Rochebrune has been signally unfortunate in his artists. Of all the figures of Chitons published by him I have not yet seen a correct one; most are so radically bad that no dependence whatever can be placed upon them. The same is true of his figures of fossil Chitons.

From the above sketch it will be seen that the chief workers upon the classification of Chitons have been few in number, the publications of BLAINVILLE, GRAY and CARPENTER successively marking epochs in the taxonomic history of the group.

Classification of Chitons.

The classification given in this work is based mainly upon characters furnished by the articulating surfaces of the valves. The hard structure in this group is comparable to the vertebrate skeleton in the great variety of stresses to which it is subject. Each valve is not only acted upon by external forces and its body-muscles, but by the valves before and behind it, and by the girdle. Hard parts of great complexity have thus arisen, offering to him who can decipher their story clues as valuable for the construction of genealogical lines as have been found in the limb-bones of mammals, or the hinge-teeth of bivalve mollusks. The development of the gills, foot and girdle has been given due weight, and for the first time, systematic use has been made of the sense organs of the shell (tegmentum), and the system of sculpture of the latter. The non-differentiation of the dentition throughout the group has prevented the use of that character usually so important.

The *Polyplacophora* known to us, form a group remarkably homogeneous, when we consider the vast antiquity of the stock. The fossil forms are yet few in number and imperfectly known; so that all attempts to trace the mutual relationships and descent of modern genera must still be based upon the morphology of living forms. The complex inter-relations of the various families and genera, the number of phyla, and especially the wonderful parallel developments of different stocks, all render a linear arrangement of groups highly unsatisfactory. The accompanying diagrams show the main facts of classification and descent much more clearly.

It is commonly known that the earlier (Palæozoic) Chitons are without exception, destitute of plates of insertion, and belong, therefore, to the family *Lepidopleuridæ*. This family has survived to the present day, but the species are now few in number and of small size. The higher genera of *Lepidopleuridæ* possess insertion plates on some or all valves, but they are unslit; and it is to this branch that the genesis of the higher Chitons is to be traced. The lowest *Ischnochitonidæ* known have already become well differentiated by the development of a definite system of slits.

The Ischnoid stock must be regarded as a synthetic or unspecialized type of Chitons. In other words the common ancestors of the other families of the Chitons (except *Lepidopleuridæ*), would probably, if known to us, be classed as *Ischnochitonidæ*. From this generalized Ischnoid stock specialization proceeded in two directions: (I)

toward greater definiteness in the positions of the slits, and often toward the degeneration of the shell; leading (*a*) through *Callistoplacinæ* to the *Mopaliidæ*, and (*b*) through *Acanthochitidæ* to covered forms, *Cryptochiton*, and to worm-like forms, *Cryptoplacidæ;* the last having fewer slits than any other Chitons. In the other direction (II) the slits became generally more numerous, the insertion-plates are roughened for the stronger adhesion of the girdle, the valves increase in general effectiveness as a protective armor, and their sense organs became highly developed. This phylum (*Chitonidæ*) culminates in *Tonicia, Acanthopleura, Schizochiton, Enoplochiton, Liolophura*, etc.; and may be regarded as the highest group of Polyplacophora.

NOTE.—It must be understood that in cases where the classification below given differs from that in the descriptive part of this work, the former represents the mature views of the author. Page 23 in the text, should be cancelled, as it was written when but a small portion of the groups there discussed had been studied. The synopses given on pp. 24–25, and 148–149 also require correction.

Synopsis of Classification of the Order Polyplacophora.

I. Superfamily EOPLACOPHORA.

Family *Lepidopleuridæ* Pilsbry.

Genus Lepidopleurus Risso. p. 2.
Section Deshayesiella Cpr., p. 16.
Genus Hanleya Gray, p. 17.
*
Genus Hemiarthrum Cpr., p. 19.
*
Genus Microplax Ad. & Ang., p. 21.

II. Superfamily MESOPLACOPHORA.

Family *Ischnochitonidæ* Pilsbry, p. 253.

Subfamily Ischnochitoninæ Pilsbry, p. 254.

Genus Tonicella Cpr., p. 40.
Genus Schizoplax Dall, p. 46.
Genus Callochiton Gray, p. 48.
Section Sterochiton Cpr., p. 52.
Genus Trachydermon Cpr. p. 67.

Subgenus Cyanoplax Pils., p. 44.

*

Genus Chætopleura Shuttlw., p. 27.
Genus Pallochiton Dall, p. 256.
Genus Dinoplax Cpr., p. 254.

*

Genus Ischnochiton Gray, p. 53.
Subgenus Stenochiton Ad. & Ang., p. 55.
Subgenus Stenoplax Cpr., p. 56.
Section Stenoradsia Cpr., p. 61.
Subgenus Ischnoplax Cpr., p. 64.
Subgenus Ischnochiton *s. s.* p. 87.
Section Lepidozona Pils., p. 125.
Section Radsiella Pils., p. 139.
Section Ischnoradsia Shuttl., p. 144.
Subgenus Heterozona Cpr., p. 65.

Subfamily Callistoplacinæ Pilsbry, p. 259.

Genus Callistochiton Cpr., p. 260.

*

Genus Nuttallina Cpr., p. 277.
Subgenus Middendorffia Cpr., p. 282.
Genus Craspedochiton Shuttlew., p. 285.

*

Genus Angasia Cpr., p. 286.
Genus Callistoplax Cpr., p. 288.
Genus Ceratozona Dall, p. 290.

Family *Mopaliidæ* Pilsbry, p. 292.

Genus Mopalia Gray, p. 294.
Genus Placiphorella Cpr., p. 305.
Genus Plaxiphora Gray, p. 311.
Section Guildingia Cpr., p. 329.
Section Fremblya H. Ad., p. 330.
Subgenus Placophoropsis Pilsbry, p. 313.

Family *Acanthochitidæ* Pilsbry.

Genus Spongiochiton Cpr.
Genus Acanthochites Risso.
Section Notoplax Ad.

Section Cryptoconchus Blv.
Section Loboplax Pils.
Genus (?) Leptoplax Cpr.
Genus Katharina Gray.
*
Genus Amicula Gray.
*
Genus Cryptochiton Midd.

Family *Cryptoplacidæ* Dall.

Genus Cryptoplax Blainv.
Genus Choneplax Cpr.

III. Superfamily TELEOPLACOPHORA.

Family *Chitonidæ* Pilsbry.

Subfamily Chitoninæ Pilsbry.

Genus Chiton Linn., p. 149.
Section Radsia Gray, p. 189.
Section Sclerochiton Cpr., p. 188.
*
Genus Eudoxochiton Shuttlw., p. 192.

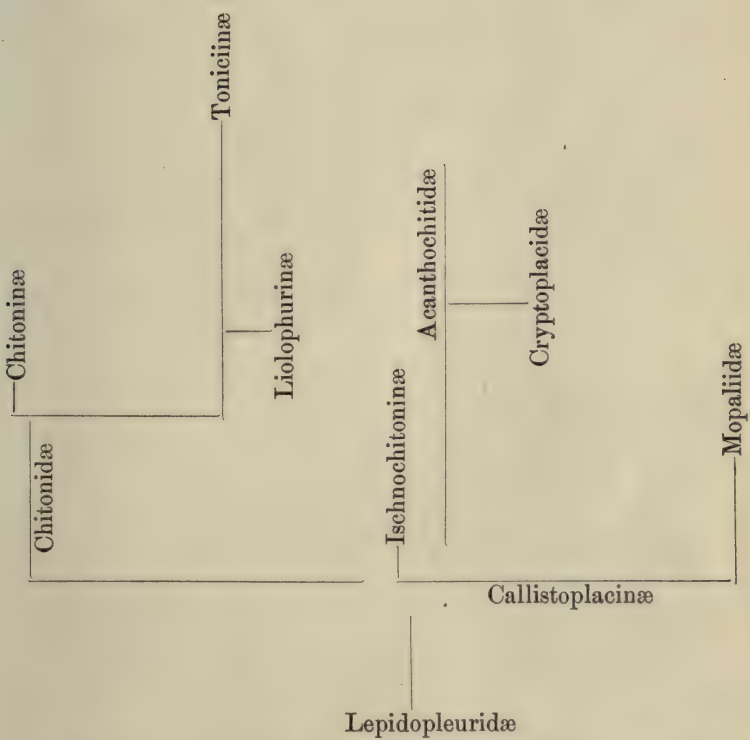
Subfamily Toniciinæ Pilsbry.

Genus Tonicia Gray, p. 194.
Section Fannettia Dall, p. 212.
Genus Acanthopleura Guild., p. 213.
Subgenus Mesotomura Pils., p. 218.
Subgenus Acanthopleura *s. s.*, p. 219.
Subgenus Maugeria Gray, p. 226.
Subgenus Amphitomura Pils., p. 230.

Subfamily Liolophurinæ Pilsbry, p. 232.

Genus Schizochiton Gray, p. 234.
*
Genus Lorica Ads., p. 236.
Section Loricella Pils., p. 238.
*
Genus Enoplochiton Gray, p. 252.
Genus Onithochiton Gray, p. 244.
Genus Liolophura Pilsbry, p. 239.

Phylogenetic diagram of the families and subfamilies of Polyplacophora.



A diagram illustrating the phylogeny of the genera of *Ischnochitoninæ* is given on page 254; another illustrating that of the genera of *Chitonidæ* is given below; and the descent of the genera of *Acanthochitidæ* is shown under the head of that family. The mutual relations of the genera included in *Callistoplacinæ* are not clear to me and require much further investigation; but the views expressed on pages 259, 260 may possibly suggest a clue to the super-generic groups.

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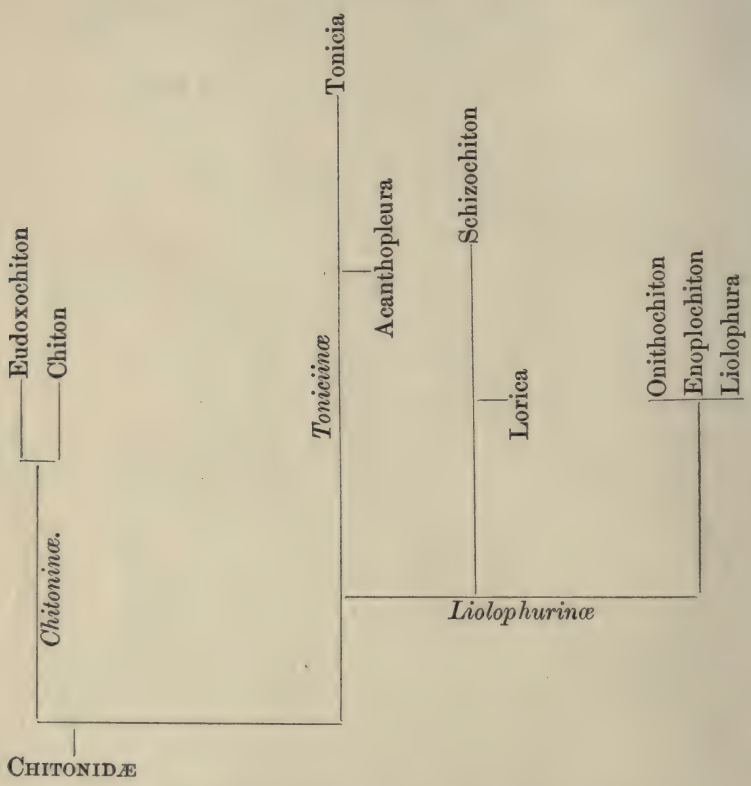
Phylogenetic diagram of the genera of Chitonidæ.



ANALYTICAL KEY TO GENERA OF POLYPLACOPHORA.

a. *Valves lacking insertion plates, or if present they are unslit (Lepidopleuridæ).*

b. Valves entirely exposed, not immersed,

c. Insertion plates completely absent, LEPIDOPLEURUS, p. 2.

cc. Head valve having an insertion plate, grooved outside but unslit; valves ii–viii without plates, girdle spinulose HANLEYA, p. 17.

ccc. Head and tail valves only having unslit insertion plates; girdle thick, sparsely downy, with sutural pores HEMIARTHRUM, p. 19.

bb. Valves partly covered, the exposed portions small, separated MICROPLAX, p. 21.

aa. *All valves possessing insertion plates; valve* i, i–vii or i–viii *having slits; teeth smooth or but slightly roughened between the slits, never closely, finely pectinated; valves lacking eyes.*

b. Surface of intermediate valves divided into lateral and central areas by a diagonal (often indistinct), extending from beak to outer front angle of tegmentum; or if this is not clearly the case, the posterior valve has an even, crescentic series of well developed teeth; all valves having slits.

c. Posterior valve having a crescentic series of well developed teeth (*Ischnochitonidæ*).

d. Anterior and side slits not corresponding in position to external ribs (*Ischnochitoninæ.*)

e. Valves porous at the eaves, apparently smooth outside or nearly so; teeth sharp, smooth; girdle naked, sparsely hairy or densely covered with elongated corneous bodies, the visible ends of which appear like diamond-shaped scales (Tonicelloid group).

f. Sutural plates not connected across the sinus; girdle naked; side-slits single; gills shorter than the foot.

g. Median valves having a median slit filled with cartilage, SCHIZOPLAX, p. 46.

gg. Median valves normally calcified, TONICELLA, p. 40.

ff. Sutural plates connected across the sinus, or side-slits several, or both; girdle either sparsely hairy, naked, or with compact diamond-patterned covering; gills as long as the foot, CALLOCHITON, p. 48. (This includes the typical forms of *Trachyradsia*, p. 83.)

fff. Girdle with chaffy scales or pap-

illose; gill-row short or long, TRACHYDERMON, p. 67.

ee. Valves solid at eaves, generally with beaded sculpture; teeth sharp, often rugose outside; girdle leathery with few or many hairs or spiculæ, never scaly; gills as long as the foot (Chatæpleuroid group).

f. Sinus squared, the sutural plates not connected across it; girdle hairy or naked.

g. Mucro in front of the middle, CHÆTOPLUERA, p. 27, [*and appendix.*

gg. Mucro decidedly posterior, PALLOCHITON, p. 256.

ff. Sutural plates connected across the sinus; girdle thick, bearing minute clumps of short spicules, DINOPLAX, p. 254.

eee. Valves solid at eaves; girdle densely covered with imbricating scales, rarely elongated like fluted pillars (Ischnoid group) ISCHNOCHITON.

f. Shell much elongated, narrow (gills short at both ends; foot notably dilated and produced in front, at least in some of these sections).

g. Girdle scales uniform; mucro near the middle

h. Valves longer than wide, roundly arched, with several side slits; animal Julus-like, *Stenochiton* p. 55.

hh. Less elongated; American forms *Stenoplax*, p. 56.

gg. Girdle scales very unequal;

mucro elevated, posterior,
Ischnoplax, p. 64.

ff. Shell not greatly elongated.

g. Girdle clothed with large and small intermingled scales, *Heterozona*, p. 65.

gg. Girdle scales regular, uniform.

h. 1 slit on each side of median valves

i. Girdle scales flat, *Ischnochiton*, p. 86.

ii. Girdle scales very convex, *Lepidozona*, p. 125.

hh. 2 or more slits on each side,

i. Girdle scales flat, *Radsiella*, p. 139.

ii. Girdle scales convex, *Ischnoradsia*, p. 144.

dd. Anterior and side slits corresponding in position with external ribs (Callistoplacinæ).

e. Surface of valves having strong radial ribs; girdle densely clothed with imbricating scales,
CALLISTOCHITON, p. 260.

ee. Surface of valves granulated or pebbly; girdle not densely imbricated with scales.

f. Anterior valve with more than 7 slits; sinus very spongy; mucro posterior,
NUTTALLINA, p. 277.

ff. Anterior valve with 5 slits; mucro subcentral, not posterior,

g. No sutural pore tufts.
CRASPEDOCHITON, p. 285.

gg. Sutural pore tufts present,
ANGASIA, p. 286.

eee. Surface of valves wrinkled or ribbed; girdle naked except for hairs or corneous spines.

f. Valves having very strong radial ribs; girdle naked, with sutural tufts, CALLISTOPLAX, p. 288.

ff. Valves not very strongly sculptured; girdle tough, with corneous curved spine-like processes, CERATOZONA, p. 290.

cc. Posterior valve having a sinus behind, with one slit or none on each side; girdle hairy or nude, never scaly (*Mopaliidæ*). *See key to genera on page* 293.

bb. Surface of intermediate valves divided into a narrow dorsal area, and latero-pleural areas, the latter formed by the union of the lateral and the pleural (or sides of the central) areas; valves more or less covered by the naked, spiculose or hairy (never scaly) girdle; gills generally short (Acanthochitoid phylum).

c. Posterior valve either having well developed slits, or a posterior sinus, or both; not funnel-shaped, anterior valve with 5 or more slits (*Acanthochitidæ*, see next volume for species).

d. Valves not completely covered by the girdle, the first 7 having their apices posterior and marginal.

e. Anterior valve having 5 regularly placed slits; exposed portion of each median valve much longer than wide.

f. Girdle provided with pores bearing tufts of bristles; posterior teeth wanting or irregular ACANTHOCHITES.

ff. Girdle naked; posterior valve with 6 slits, the teeth even, spreading LEPTOPLAX.

fff. Girdle spongy, produced forward as in *Placiphorella* SPONGIOCHITON.

ee. Anterior valve having the slits irregularly spaced, more than 5; posterior valve with a median angular tail sinus, its edge with several unequal notches or slits; exposed part of valves flask-shaped KATHERINA.

eee. Anterior valve having 6–8 unequal slits; posterior valve 2 slits and a median wave; exposed part of each valve far shorter than the ridge of the valve, heart-shaped AMICULA.

dd. Valves completely covered by the girdle, their apices not marginal, CRYPTOCHITON.

b. Median valves partly lacking side slits; tail valve with 2 or no slits

cc. Posterior valves without distinct slits, and having no posterior sinus; more or less hollowed out and funnel-shaped; anterior valve with 3–5 slits; body rather vermiform; gills short, posterior (*Cryptoplacidæ*; see next volume for species).

d. Valves small, narrow and sagittate, generally partly disjointed; not covering the body to any considerable extent CRYPTOPLAX.

dd. Valves transverse, all strongly imbricating; covering a considerable portion of the upper surface CHONEPLAX.

aaa. All valves, or valves i–vii, *possessing insertion plates cut into teeth by slits; the teeth sharply sculptured or "pectinated" outside by fine vertical grooves* (*Chitonidæ*).

b. Valves lacking eyes (*Chitoninæ*).

c. Girdle scaly CHITON, p. 149.

cc. Girdle leathery, with short bristles EUDOXOCHITON, p. 192.

bb. Valves having eyes; posterior valve not deeply sinused behind, its insertion plate developed (*Toniciinæ*)

c. Girdle leathery, nude or nearly so, TONICIA, p. 194.

cc. Girdle covered with calcareous spines or spinelets, ACANTHOPLEURA, p. 213.

bbb. Valves having eyes (rarely subobsolete); posterior

valve either having a deep sinus behind, or lacking the insertion plate altogether (*Liolophurinæ*).

c. Median valves having eyes developed only on the diagonal ribs. Sinus notably narrow and small. Insertion plates of tail valve a low, rounded, rugose ridge more or less notched, slit or waved upward in the middle behind, or sharp, long and pectinated.

d. Eyes developed on radiating ribs of all valves; the ribs of head valve corresponding to internal slits; girdle having minute spines; shell elongated, posterior valve and girdle slit behind SCHIZOCHITON, p. 234.

dd. No eyes on head valve, its riblets not corresponding to slits; girdle densely scaly LORICA, p. 236.

cc. Eyes developed upon the lateral areas. Sinus wide and large. Insertion plate of the tail valve reduced to a smooth ledge or ridge, having no posterior sinus or wave.

d. Valves polished or eroded, dark brown outside and within, having excessively minute eyes scattered over lateral areas and head valve (when not eroded); interior very densely, minutely and peculiarly grooved and punctured. Girdle fleshy, bearing separated rude scales, ENOPLOCHITON, p. 252.

dd. Valves polished, colored outside, porcellanous and smooth within, having the eyes disposed in radial bands on each lateral area and the head valve. Girdle leathery, microscopically velvety, ONITHOCHITON, p. 244.

ddd. Valves lusterless, granulated, having minute eyes scattered over the lateral areas, sides of the central areas, and head valve. Girdle densely covered with stout calcareous spines LIOLOPHURA, p. 239.

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Family LEPIDOPLEURIDÆ.

Leptoidea CARPENTER.—*Leptochitonidæ* DALL, 'Blake' Gastrop. p. 414, 1889.—Genus *Holochiton* FISCHER, Manuel de Conchyl. p. 877, 1885.

Chitons in which the head and tail valves are similarly articulated, and having the insertion plates either obsolete, or if present, without slits. Girdle finely scaly or bristly; gills short, posterior.

This family is readily known by the entire absence of insertion-plates, or the simple, *unslit* character of them when present. The living species are few in number, and mainly either northern in distribution, or living at considerable depths. All of the Palæozoic Chitons yet known belong to this family, and this fact, together with the weak, imperfect articulation of the valves, causes us to regard the Leptoids as the most primitive of the existing groups.

Synopsis of Genera.

A. *Valves entirely exposed, not concealed by the girdle.*

B. Girdle without pores.

Genus I. LEPIDOPLEURUS Risso, 1826.

Insertion plates absent. Girdle with minute, gravelly, smooth or striated scales, usually with a marginal fringe of longer scales. Type, *L. cajetanus* Poli.

Section *Deshayesiella* Carpenter, 1878. Girdle having delicate spines and chaffy scales. Valves curved and beaked; sutural plates and sinus as in *Leptochiton*. Type, *L. curvatus* Cpr.

Genus II. HANLEYA Gray, 1857.

Front valve having an insertion plate which is grooved outside but without slits. Intermediate and posterior valves without insertion plates. Girdle finely spiculose, without pores. Type, *H. hanleyi* Bean.

BB. Girdle with pores at the sutures.

Genus III. HEMIARTHRUM Carpenter, 1876.

Head and tail valves having smooth, unslit insertion plates, the intermediate valves without insertion plates. Sinus broad and

spongy. Girdle downy, having small, tufted pores. Type, *H. setulosum* Cpr.

AA. Valves partly covered, the exposed portions small and separated.

Genus IV. MICROPLAX Adams & Angas, 1864.

Insertion plates smooth and thin, well developed in all the valves. Sutural plates and sinus obsolete. Girdle thin, most minutely granular, not poriferous. Type, *M. grayi* Ad. & Ang.

Genus I. LEPIDOPLEURUS Risso, 1826.

Lepidopleurus Risso, Hist. Nat. l'Eur. Mérid., iv, p. 267, 1826, (in part; first species *L. cajetanus* Poli).—Sars., Moll. Reg. Arct. Norv., 1878, p. 110. Not *Lepidopleurus* of H. & A. Adams, Carpenter, Dall, *et al.*—*Leptochiton* Gray, Proc. Zool. Soc. Lond. 1847, p. 127; Guide Moll. B. M., p. 182, 1857.—Carpenter, *MS.* p. 1,—Dall, Proc. U. S. Nat. Mus. 1878, p. 314.—*Leptochiton*, in part, of H. & A. Adams, Gen. Rec. Moll. i, p. 473, and of Chenu, Manuel, i, p. 381.

In *Lepidopleurus* the insertion plates are completely absent; the girdle is narrow, with minute striated or smooth scales, and some longer scales at the edge.

The present genus has hitherto been known as *Leptochiton*, but the rejection of that name seems to be inevitable as will be seen from the following:

History of the name Lepidopleurus. The first publication of *Lepidopleurus* was in Risso's Histoire Naturelle des principales productions de l'Europe Méridionale, vol. iv, p. 267, 1826, where it is quoted as of Leach's *ms.* It is characterized as having the triangular lateral areas elevated and the girdle covered with small scales, and in it are included (711) *L. cayetanus* Poli, (712) *L. corallinus* n. sp. and (713) *L. sulcatus* n. sp. Of these, the first species belongs to the group which Gray subsequently named *Leptochiton*, and the two latter belong to the genus *Chiton* as restricted to Linnæus' type. It is therefore evident that if used at all, the name *Lepidopleurus* can properly be used for *Leptochiton* only. It is greatly to be regretted that it was not so used by Gray, as much subsequent confusion would have been avoided. The republication of the

genus in Gray's edition of Leach's *Synopsis Moll. Gt. Brit.*, in 1852, need not be considered here as it has no bearing upon nomenclature. In 1858, Messrs. H. and A. Adams, in the *Genera of Recent Mollusca*, adopted Risso's name for a large list of species composed mainly of *Ischnochitons*, but including also species of *Callochiton*, *Leptochiton*, etc., among them *L. cajetanus* Poli. Carpenter in his later writings used *Lepidopleurus* to cover that group of Ischnochitons having the girdle clothed with large, smooth convex scales, like those of the typical Chitons. Nothing can be said in favor of this use of the name, for Carpenter expressly states that *the species cited by Risso are excluded* from the group as rehabilitated! It is, therefore, obvious that *Lepidopleurus* Cpr. is a totally distinct group from *Lepidopleurus* Risso. No argument is needed to show the untenability of Carpenter's position. In 1889, Carus, in his *Prodromus Faunæ Mediterraneæ*, has used *Lepidopleurus* as a subgenus under *Chiton* (which he places in the Ischnoidea!), and has included in it species of *Trachydermon* and *Ischnochiton*, as well as *Leptochiton cajetanus*. In 1878 G. O. Sars correctly restricted *Lepidopleurus* to the genuine Leptochitons.

L. CANCELLATUS Sowerby. Pl. 3, figs. 54, 55, 56, 57, 58.

Shell small, elongated, much elevated, regularly arched, not angled. Orange-ashen or whitish.

Anterior valve radiately, evenly, very finely, granose-lirate.

Central areas of the intermediate valves having distinct longitudinal, fine, close granulous liræ, the granules being sometimes arranged in transverse lines also, giving a latticed appearance; lateral areas distinct, decidedly raised, convex, having radiating but rather irregular rows of granules.

Posterior valve with central elevated apex; posterior slope concave.

Interior white, the sutural plates small, triangular; jugal sinus very broad.

Girdle narrow, densely beset with delicate, scarcely imbricating or striated, scales (figs. 55, 57).

Length 5½, breadth 2½ mill.; divergence 80°.

Northern Atlantic and Arctic Seas.—Britain; Norwegian Coast in 50–100 fms.; *Lofoten Is.* 300 fms.; *Greenland; South to Gulf of Lyons, Vigo, Spain (and Dalmatia?). Northern Pacific.—Alaska, at Unalashka, Shumagins, Port Etches and Sitka Harbor*, 6–100 fms.

Chitons cancellatus Sowb (as ? of Leach *ms.*), Conch. Ill. f. 104–5, 1839.—Reeve, Conch. Icon. t. 59, f. 152.—Forbes & Hanley, Hist. Brit. Moll. ii, p. 410, t. 59, f. 3.—Jeffreys, Brit. Conch. iii, p. 217; v, p. 198, t. 56, f. 1.—*Lepidopleurus cancellatus* Sars, Moll. Reg. Arct. Norv. p. 111, t. 7, f. 6; t. i, f. 8.—*Leptochiton cancellatus* Cpr. *MS.*, p. 3.—Dall, Proc. U. S. Nat. Mus. 1878, p. 315.—*Chiton albus* Pult. not Linn., *fide* Hanley.—*Chiton asellus* Midd., not of Lowe.—*Ch. rissoi* Auct., not Payr.—*? Ch. islandicus* Gmel., Syst., p. 3206.

This species without careful inspection will usually be confounded with small specimens of *Trachydermon albus*, but a glance at the sculpture is sufficient to separate it. From several other species of *Leptochiton* it is less readily distinguished, and a magnifier is indispensable. The differential characters are as follows:

The pustules which constitute most of the sculpture are arranged like overlapping coins or a solid-linked chain in lines which in the dorsal area are nearly parallel with the longitudinal axis of the animal. The lateral areas are distinct, and the pustules upon them are arranged in rather indistinct lines radiating toward the lateral ends of the valves, at nearly right angles to the lines on the dorsal area. The sculpture on the mucro is more delicate than elsewhere. The apex of the posterior valve is not sunken and is not so sharp as in other species compared with it here; the girdle is scaly, with also some small, spinose, transparent scales near the margin. There are five gill plumes on each side, prominent and near the vent. There appear to be two fenestra on each side. The lateral areas and other portions of the valves are nearly always colored with blackish or ferruginous patches, but these, as with *Trachydermon albus* seem to be really composed of extraneous matter. In *L. fuliginatus* Ad. & Rve., the pustules are much smaller, and while having a general longitudinal arrangement on the dorsum, do not form regularly defined rows or chains. The areas are not raised above the dorsum. The shell is much larger and more elevated, with a somewhat sunken and quite sharp posterior mucro. The other mucrones are not raised but about them the sculpture is more regularly aligned than elsewhere. I have compared the valves of a typical specimen from Korea, collected by Belcher. Reeve's figure of the sculpture is very bad, as are most of his details. *L. alveolus* Sars is a very distinct species, though it has been confounded with this. Its sculpture is composed of larger and rather more sparse,

isolated pustules, absolutely irregular in distribution and of the same size on the mucro and elsewhere. Nowhere do they form lines. The arch of the back is peculiarly round, the lateral areas not raised and barely distinguishable. The girdle seems similar. I have compared typical examples.

L. concinnus Gould, from the types, is of a different color, and has a much stronger and different sculpture like lines of rope.

L. internexus Carpenter and var. *rugatus* Cpr., are more like *concinnus*, but distinguished from either by the peculiar girdle covered with subequal scales.

L. nexus Carpenter more nearly resembles *cancellatus* but the sculpture is of separate, not lapping, rounded rhomboidal pustules; the mucrones are much more pronounced, and the white ground is prettily marbled with black and gray inherent coloration. The name *cancellatus* is a misnomer, since it is only in certain lights that any trace of reticulation can be observed faintly. The young are flatter than the adults. It bears no resemblance to *L. asellus*, with which Middendorff united it, probably without a comparison.

L. arcticus of Sars seems to be a finely grown variety of this species, if one may judge from the figures; at least, no differential characters are given which seem to be of a permanent character, and not subject to variation within the limits of a species.

The gills occupy a space corresponding to the posterior quarter of the foot; there are about eight or ten on each side. The mantle edge is plain and thick. The veil is plain. The muzzle is rounded, with a little papilla at the posterior corner on each side (*Dall.*)

L. ARCTICUS Sars. Pl. 3, figs. 59–63.

Shell subdepressed, dorsal keel obsolete, lateral areas little conspicuous. Posterior valve smaller than the anterior, subrhomboidal, roundly produced in front. Median plates three times as long as broad, the front margin truncate in the middle. Surface of the valves nearly smooth, indistinctly granulose. (*Sars.*)

Length 12 mill.

Spitzbergen, Greenland, Vadsö and Finmark, 20–100 fms.

Lepidopleurus arcticus SARS, Moll. Reg. Arct. Norv. p. 112, t. 7, f. 7.—*Chiton arcticus* JEFFREYS, P. Z. S. 1882, p. 668.

Dall, judging from the description and figures, considered this a form of *L. cancellatus*. Jeffreys, who found the species in the

'Lightning' dredgings, says that it differs from the white variety of *cinereus* [=*asellus*] in its comparatively greater length and more raised or arched form, in the less distinct or regular catenation of the granules which cover the surface, and in the prominence of the lateral areas.

L. ALVEOLUS Sars. Pl. 2, figs. 23–31.

Shell quite convex, back equally arched, without trace of a keel or defined lateral areas; valves rather elongate, the posterior larger than the anterior valve, half-round, truncated by a straight line in front; median valves subequal, their posterior margins straight, anterior margins lightly emarginate in the middle. Entire surface sculptured with minute ovate tubercles, regularly disposed. (*Sars.*)

Length 16 mill.

North Atlantic at Bergen, Lofoten, Finmark, 150–300 fms.; *Bay of Biscay*, 120–664 fms.; *Gulf of St. Lawrence between Cape Rosier and the S. W. point of Anticosti Id.*, 220 fms.; *St. George's Bank, Gulf of Maine*, 150 fms.

Chiton alveolus (SARS *ms.*) LOVEN, Ind. Moll. Lit. Scand. p. 27, 159, 1846.—JEFFREYS, P. Z. S. 1882, p. 668.—*Lepidopleurus alveolus* G. O. SARS, Moll. Reg. Arct. Norv. p. 110, t. 7, f. 3; t. i, p. 7, 1878.—*Leptochiton alveolus* DALL, Proc. U. S. Nat. Mus. 1878, p. 317.—HADDON, Challenger Rep. vol. xv, p. 12.

L. PERGRANATUS Dall. *Unfigured.*

Shell elongated, moderately elevated, regularly arcuate, without jugum. Pale waxen, sometimes white. Valves wide, without apices. Front and back valves more or less concave; posterior valve without elevated apex. Sculpture as in *L. cancellatus*, but the granules larger, lateral areas less defined. Sutural plates elongated. Girdle wide, densely beset with delicate scales. (*Dall.*)

Length 12, breadth 6½ mill.

Near Dominica, West Indies, in 138 fms.

Leptochiton pergranatus DALL, 'Blake' Rep. p. 414, 1889.

This fine species is nearest the Atlantic *L. cancellatus* Sowerby, and the Japanese *L. fuliginatus* Ad. & Reeve. It differs from both in its concave or excavated, instead of convex, terminal valves, in the absence or obsolete condition of the posterior mucro, in its much larger and more regular granules, and in the subdepressed appearance also of the part of the median valves near the girdle on each side. It is larger than *cancellatus* and smaller than *fuli-*

ginatus, and without the dingy blackish painting of either. *L. cancellatus* is narrower, higher, and with a sharper median angle. In *L. fuliginatus* the middle valves are shorter from front to back, the sutural laminæ smaller and much more triangular. There is no sign of a mucro on these valves, but in *L. pergranatus* there is a beginning of one, quite perceptible. The latter is a proportionally wider and flatter species, with a stronger and more prominent girdle densely set with elongated silvery scales like short stiff gray hairs; these form a pretty fringe at the periphery. The sculpture follows the pattern of *L. cancellatus*, but the lateral areas are less clearly defined, the granules are more clearly cut, more regularly arranged and larger than in any of the species hitherto known. There are twelve gills on each side, reaching forward to about the middle of the sixth valve. (*Dall.*)

L. BELKNAPI Dall. Pl. 1, figs. 18–22.

Shell elongated, much elevated, dorsally angled; whitish, more or less tinged with ashen or black. Valves elevated, with distinct apices; mucro central, conspicuous. Sculpture as in *L. alveolus*, but the granules of the dorsal areas sparse, and disposed in quincunx. Posterior valve concave below the apex, sinuated behind. Girdle narrow, having delicate spicules toward the margin. (*Dall.*)

Length 10, breadth 3 mill.; divergence 90°.

North Pacific Ocean in lat. 53° 08′ *N., lon.* 17° 19′ *W.*, at a depth of 1006 fms.; *off Cape Bolinas, Luzon, Philippines*, 1050 fms.

Leptochiton belknapi DALL, Proc. U. S. Nat. Mus. 1878, p. 1, Jan., 1878; *l. c.* p. 317.—HADDON, Challenger Rep. xv, p. 10, t. 1, f. 2; t. 2, f. 2.

This specimen much resembles *L. alveolus*, to which I at first referred it. A careful microscopical examination, however, shows differences which I am disposed to consider specific; but I have but one specimen, and others might show modifications in these particulars. The differential characters are as follows: In *alveolus* the pustules are distributed evenly, closely and in no pattern whatever, all over the surface. In *belknapi*, they are more widely separated and arranged in quincunx on the dorsum, the spaces seeming to radiate from the median dorsal line. In *alveolus* the lateral areas are barely perceptible. In *belknapi* they are raised, concentrically rugose, and the pattern of the pustular arrangement is different and more irregular than that on the dorsum. In *belknapi*

also the girdle is very thin, narrow, and sparsely set with small pellucid spicules near the margin. The posterior mucro or apex of the posterior plate, in *belknapi*, is prominent, overhangs a shallow concavity and from its point there diverge anteriorly four depressed lines, the outer two to the anterior lateral angles of the plate, the inner two equidistant from each other and the outer lines. Between these lines the plate is swelled, forming three rounded ridges, extending forward like the leaflets of a trefoil or clover. Nothing resembling this has been observed on any of the other species which have come under my notice. The soft parts in spirits appear to resemble the other species compared with it. It is evidently adult. (*Dall.*)

The figures represent the form dredged by the 'Challenger' off Luzon, Philippines. Haddon describes these specimens as follows:

Shell.—Brittle, closely covered with large, round, smooth tubercles. The sides meet at an angle of about 110°. Sutural laminæ small.

Anterior valve.—With a few irregular lines of growth, thickly covered with irregularly disposed tubercles.

Intermediate valves.—Central areas: with a shallow depression on each side of the median ridge, which gives the latter a pinched appearance; this depression is most apparent at the hinder border of each valve. The tubercles have a general arrangement in oblique lines radiating forwards from the keel and at the same time in lines concentric to the umbo, but these two series of lines are not always regular, and the tubercles often appear to be irregularly disposed. A series of short concentric rows usually demarcate the anterior border of the lateral areas. Lateral areas: scarcely apparent; a groove indicating a line of growth occurs at a short distance from the girdle; tubercles irregularly disposed, with a tendency, however, to concentric lines.

Posterior valve.—With a small subcentral umbo, behind which is a slight depression. Anterior area: the lateral longitudinal depression causes the jugum to be slightly prominent and thus gives the anterior area a somewhat trilobed appearance; the tubercles radiate from the rounded keel. Posterior area; with concentric lines of growth and closely set tubercles.

Girdle.—Narrow, thickly covered with delicate small oval scales; longer, narrower and more pointed scales occur along the border and in the angles between the valves.

Color.—Grayish-white.

Size.—Length about 12 mm.; breadth 5 mm.; height about 2·5 mm.

Gills.—Forming a short posterior row, six or seven in number.

This species is considerably larger and coarser than the preceding (*L. benthus*). The tubercles are twice the size and closer together. The shell is also comparatively sharply keeled, instead of having a gently rounded appearance.

L. BENTHUS Haddon. Pl. 1, figs. 1–13.

Shell.—Delicate, brittle, surface with minute inconspicuous short ridges more or less radially disposed, and studded with small tubercles. The sides meet at a rounded angle of about 100°. Sutural laminæ small.

Anterior valve.—With minute scattered tubercles, which pass towards the apex into low tubercular ridges, having a concentric arrangement.

Intermediate valves.—Central areas: The minute surface ridges, when visible, are longitudinally disposed on the jugum, but become radial or oblique on the pleura. The tubercles are round on the jugum, but become somewhat oval on the pleura, and there appear to be concentrically arranged, although in some valves they seem to more or less regularly diverge from the apex. Lateral areas: The surface ridges are radial and more pronounced than elsewhere. On the upper portion of the areas there are transverse low ridges placed further apart than the former; these ridges by being interrupted gradually pass into tubercles. The tubercles are round, distinctly smaller than in the central areas, and more scattered.

Posterior valve.—With a small central umbo. Anterior area: With concentric tubercles, as in the lateral areas. Posterior area: Similar to the anterior valve.

Girdle.—Narrow, with delicate scales, which form a minute fringe at the edge.

Color.—Greenish-white with one or two irregular reddish-brown flecks.

Size.—Length, 8 mm.; breadth, 3.5 mm.

Northern Pacific, *Lat.* 35° 41′ *N.*, *long.* 157° 42′ E., in 2300 fms.

L. benthus HAD., Chall. Rep. xv, p. 10, t. 1, f. 1, t. 2, f. 1.

Gills.—Seven in number, extending between the prominent anus and postero-lateral angle of the foot. The gill row is one-seventh

of the total length of the body, the proportion with regard to the length of the foot is 1 : 4.5. They are of moderate size, the middle being the largest, slightly decreasing behind but much more so in front. (*Haddon.*)

L. FULIGINATUS Adams & Reeve. Pl. 4, fig. 88.

Shell elongate, elevated, whitish, tawny-ashen sometimes soiled; apices eroded; jugum rounded. Mucro moderately elevated, posterior slope very concave; jugal area hardly defined; central area hardly sculptured; lateral areas quite elevated, frequently sculptured with irregular concentric incremental wrinkles; jugal sinus wide and straight. Girdle narrow, very thin, thickly covered with very delicate small and fugacious scales, which are somewhat elongated and purplish. (*Cpr.*) Length 20, breadth 9¼ mill.; divergence 90°.

Korea.

Chiton fuliginatus AD. & RVE., Conch. Icon. t. 26, f. 174, 1847.—*Leptochiton fuliginatus* A. & R., CPR. *ms.* p. 4, 5.—DALL, Proc. U. S. Nat. Mus. 1878, p. 318, 316.

This specimen is an approach to *Stenoplax* in its outward form and the character of its girdle covering. The scales appear smooth, and have the shape of those of *Stenoplax*. It has a curious general resemblance to *Trachydermon albus*, but the absence of insertion plates at once distinguishes it. The concentric furbelowing at the sides is variable. (*Cpr.* from B. M. specimens.)

See remarks under *L. cancellatus* for further distinguishing characters of this species.

L. CATILLUS Reeve. Pl. 4, fig. 87.

Shell ovate, attenuated anteriorly; terminal valves and lateral areas of the rest concentrically ridged, radiated with minute granules, central areas very finely grooved and cancellated, whitish, ligament horny, arenaceous (*Reeve.*)

Habitat unknown.

C. catillus Rv. Conch. Icon. t. 23, f. 159, 1847.—*Leptochiton catillus* Rv., CPR. *MS.* p. 6.

Might easily be taken for *stramineus* Sby. outside. Coarsely granose-lirate, like the Mogador specimen [*L. granoliratus*]; girdle gravelly. The sculpture consists of longitudinal granose liræ upon the central areas, and radiating granose liræ upon the lateral areas. No insertion plates, but the line of them is rugose. Length 9½, breadth 6½ mill.; divergence 110°. Jugum rounded. (*Cpr.*)

L. CONCINNUS Gould. *Unfigured.*

Shell minute, reddish, elliptical, vaulted, all over punctate [granulose], the points arranged in radiating, curving series; lateral areas hardly elevated, longitudinally waved. Front valve crescentic; posterior valve with an acute umbo, concentrically waved. Girdle narrow, buff. (*Gld.*) Length 8, breadth 5 mill.

Sutural plates small, subtriangular; jugal sinus very wide, flat; scales of the girdle delicate. (*Cpr.*)

Hakodadi, Japan, laminarian zone, on shells and stones.

C. (*Leptochiton*) *concinnus* GLD., Otia Conch. p. 117.—*Leptochiton concinnus* CPR. *MS.*, p. 3.—DALL, Proc. U. S. Nat. Mus. p. 318, 316, 1878.

L. NEXUS Carpenter. *Unfigured.*

Shell small, whitish-ashen, valves gothic-arched; lateral areas scarcely defined; entire surface ornamented with series of subquadrate granules, the series longitudinal upon the central, radiating upon the lateral areas and end valves, very close, scarcely interrupted. Jugum elevated, subacute; umbones inconspicuous. Mucro conspicuous, median. Inside with strong sutural lobes and a wide plane sinus to the middle valves; insertion plates obsolete. Girdle having narrow, close, striated scales and needle-shaped, crystalline bristles here and there and around the margin. (*Cpr.*)

Length 7½, breadth 4½ mill.; div. 90°.

Catalina Island, California, 20–80 fms.

Leptochiton nexus CPR., Rep. Brit. Asso. Adv. Sci. for 1863, p. 650, 1864; Proc. Cal. Acad. iii, p. 212, 1866; *ms.* p. 2.—DALL, Proc. U. S. Nat. Mus. 1878, p. 316, 319.

A variety is prettily variegated with olive, has stronger sculpture, and the valves slightly beaked. The spicules which appear on the girdle among the striated, elongated scales, are very numerous. It is curiously like the young of *Ischnochiton radians.* (*Cpr.*)

See notes under *L. cancellatus* for comparison with that species.

L. RUGATUS Carpenter, n. sp. Pl. 3, figs. 67–70.

Oval, rather convex, the lateral slopes nearly straight, dorsal ridge broadly arched. Front and back valves and lateral areas of the intermediate valves sculptured with excessively fine radiating striæ which are feebly granose, and having well-marked, coarse, concentric wrinkles; central areas having an equally minute sculpture

of longitudinal subgranose striæ. Mucro subcentral and prominent. The lateral areas are slightly raised.

Length 13–14, breadth 7 mill.; divergence 100°.

Monterey, Cal., to Todos Santos Bay, L. California.

L. (? internexus var.) rugatus Cpr. *MS.*, p. 3.

This form resembles somewhat the *L. granoliratus*, but it is much more finely sculptured, the arch of the valves is narrower and the lateral areas are less strongly marked by concentric wrinkles. It is likely that the following is merely the young of this, but I have not been able to compare typical specimens of *internexus*.

L. internexus Carpenter.

Shell similar to *L. nexus*, but much smaller, orange colored. Valves regularly arcuate, without jugum. Sutural plates small, triangular; sinus larger. Girdle with more solid scales, scarcely pilose. (*Cpr.*) Length 4½, breadth 3¼ mill.; div. 90°.

Santa Barbara, California.

L. internexus Cpr. *MS.*, p. 3.

L. kerguelensis Haddon. Pl. 1, figs. 14–17.

Shell.—Minute, smooth, or with scattered minute tubercles; the sides meet at an angle of about 100°; sutural laminæ small, triangular.

Anterior valve.—Small, smooth, with scattered aborted tubercles.

Intermediate valves.—Central area smooth, with very faint longitudinal striæ; lateral areas scarcely discernible, with faint radial striæ and minute concentric interrupted ridges towards the apex, which pass into inconspicuous small scattered tubercles.

Posterior valve.—With full rounded umbo, behind which is a shallow depression. Anterior area: similar to the central areas of the intermediate valves. Posterior area similar to the anterior valve.

Girdle.—Narrow, with delicate scales.

Color.—Uniform whitish.

Size.—Length 3, breadth 1·5 mill.

Gills.—Posterior, eight or nine in number (*Haddon.*)

Balfour Bay, Royal Sound, Kerguelen, 60 fms.

L. kerguelensis Had., Challenger Rep. xv, p. 12, t. 1, f. 3; t. 2, f. 3*a*–3*e*.

L. pagenstecheri Pfeffer. Pl. 2, figs. 39–40.

Shell elevated, roof-shaped, with the dorsal angle rounded; covered with a fine, indistinct, irregular granulation, without dif-

entiated areas. Middle valves with short but high sutural plates; no insertion plates; sinus large and deep; the division of the central and lateral areas is marked inside by a slight groove. The front margin of the anterior valve is semicircular, the posterior margins meeting at an angle of 150°. The posterior margin of the posterior valve is about the third of a circle, its front margin is seen from above as a straight line. The mucro is subcentral, somewhat more forward than behind.

The color of the valves is a pale gray-brown, irregularly covered with brown dots which are lacking at the margins, leaving there a paler, unicolored zone. The girdle is brownish, the scales white. The length cannot be given exactly, as all the specimens were strongly rolled up; but the maximum length seemed to be 4·7, breadth of the shell 2·5 of the girdle 0·8 mill. (*Pfr.*).

South Georgia.

Leptochiton pagenstecheri PFFR., Jahrb. Hamburg. Wissenschaftlichen Anstalten, iii Jahrgang, p. 107, t. 3, f. 3, 1886.

L. ASELLUS Spengler. Pl. 3, figs. 64, 65, 66.

Shell small, rather elevated, the dorsal ridge bluntly angular. Very minutely and evenly, but rather indistinctly, lirate-granulate; olive-ashen, often having longitudinal delicate pencilings of olive-green.

Anterior valve very densely, minutely and evenly granulated, the granules being irregularly, but usually visibly, arranged in radiating rows; the peripheral third of the valve having coarse concentric wrinkles.

Intermediate valves have the central areas finely densely longitudinally granose-lirate. Lateral areas closely granose, the granules arranged in radiating rows on the lower portions, which are also wrinkled like the anterior and posterior valves. The lateral areas are separated from the central area by an inconspicuous low ridge.

Posterior valve with subcentral, rather low umbo, the posterior slope concave. Interior of valves white; sutural plates small.

Lofoten Is., Norway, Iceland and Greenland, south to Gulf of Gascony.

Chiton asellus SPENGLER, Skriv. Nat. Selsk. 1797, vol. iv, p. 99. —LOWE, Zool. Journ. ii, p. 101, t. 5, f. 3, 4, 1825.—BROWN; DESHAYES in LAMARCK An. s. Vert.; MIDDENDORFF; FORBES & HANLEY, Brit. Moll. vol. ii, p. 407, t. 59, f. 1, 2.—*Chiton minimus* CHEMNITZ; WOOD; DILLWYN.—*Chiton cinereus* MONTAGU;

SOWERBY; REEVE; LOVEN; JEFFREYS, Brit. Conch. vol. iii, p. 218, v, p. 198, t. 56, f. 2; P. Z. S. 1882, p. 668., non LINNE, teste HANLEY, Ips. Lin. Conch. p. 17.—*Leptochiton cinereus* GRAY, P. Z. S. 1847, p. 127, 168 (var. white, C. "albus" exclus.) as type of genus.—*Leptochiton asellus* H. & A. ADAMS, Gen. i, p. 473.—GRAY, Guide, p. 182.—CPR. *ms.*, p. 2.—DALL, Proc. U. S. Nat. Mus. 1878, p. 318.—*? Lepidopleurus cinereus* L., SARS., Moll. Reg. Arct. Norv. p. 112, t. 7, f. 8.—*Chiton islandicus* GMEL., Syst. p. 3206.—*C. fuscatus* LEACH, not Brown.—*C. scoticus* LEACH, teste Jeffr.—*C. onyx* SPENGLER, Skrivter af Naturhistorie-Selskabet (Udforlig Be Skrivelse over det mangeskallede Conchylie Slaegt af Linne kaldet Chiton med endeel nye Arter og Varietat) Oplaest, 28 Febr., 1794. iv, 1 Heft. p. 62, 1797 *cf.* Mal. Bl. xvii, p. 113.

This species is allied to *L. granoliratus* Cpr., but that is more elevated, the central and lateral areas are more diverse in sculpture, and the concentric wrinkles are much stronger. In *L. cancellatus* the lateral areas are raised, which is not the case with the *asellus*.

"Under the microscope this species can easily be separated from *T. cinereus* Ln.(=*marginatus* Jeffr.) by external characters. In the *Trachydermon* the scales are very minute, smooth, granular, reddish and closely appressed to the girdle; in the *Leptochiton* they are gravel-like, irregularly crowded, larger, lengthened and striated. In *T. marginatus*, also, the valves are more beaked, especially in young shells." (*Cpr.*)

L. GRANOLIRATUS Carpenter, n. sp. Pl. 2, figs. 47–53.

Shell oval, rather low and *regularly convex*, not angulated dorsally. Very finely and closely granose-lirate, the anterior and posterior valves, and the lateral areas of the median valves strongly corrugated concentrically. Color "ashen-orange" or fleshy-ashen, with an ill-defined darker dorsal stripe.

The anterior valve, and the lateral areas of the intermediate valves are finely radially granose, and have a number of strong concentric wrinkles. The central areas have close fine subgranose longitudinal liræ. The lateral areas are slightly raised.

Umbo of the posterior valve somewhat in front of the middle, rather prominent; posterior slope concave, radiately granose-lirate and strongly, irregularly, concentrically wrinkled.

Girdle narrow, closely beset with delicate elongated, striated scales.

Length 10, breadth 7 mill.; divergence 130°.

Mogador.

Leptochiton granoliratus Cpr. *MS.* p. 3.

This species may easily be distinguished from *L. asellus* by its strong concentric wrinkles and the low, rounded arching of the back.

L. cajetanus Poli. Pl. 2, figs. 41–46.

Shell oblong, elevated, solid. Valves regularly arched, the lateral areas very strongly raised, coarsely sculptured.

The median areas of the valves are sculptured with longitudinal liræ, which are granulous and anastomose or branch irregularly. The head valve has strong concentric ridges, 7 to 10 in number in adults, the intervals being finely pitted or granose. The lateral areas of the intermediate valves are very much raised, and sculptured with concentric ridges like the head valve. The posterior valve is very solid and thick, its apex posterior but recurved forward and much elevated; its posterior slope is subvertical, convex, terraced.

The sutural plates are triangular and stout; the jugal sinus rather narrow. Insertion plates are completely lacking. It is lusterless, and light buff in color.

Girdle very narrow and thin, bearing most minute, close delicate *deciduous* scales.

Length 23, breadth 12 mill.

Length 11, breadth 6½ mill.

Mediterranean and Adriatic Seas; Atlantic Ocean from Cape Breton to the Gulf of Gascony; Canaries; Pliocene of Biot (Maritime Alps), of Calabria and Modenais; Pleistocene of Monte Pellegrino.

Ch. cajetanus Poli, Test. utr. Sicil., i, t. 4, f. 1, 2, 1791.—Phil. Enum. Moll. Sicil. i, p. 108, ii, p. 83.—Weinkauff, Conch. des Mittelm, ii, p. 412.—Reeve, Conch, Icon. f. 171.—*Lepidopleurus cayetanus* Poli, Risso, Hist. Eur. Mérid. iv, p. 267.—*Ch. caietanus* Poli, Jeffr., P. Z. S. 1882, p. 667.—*Leptochiton cajetanus* Poli, Cpr. *mss.* p. 7.—*Holochiton cajetanus* Poli, Buquoy, Dautzenberg and Dollfus, Moll. Mar. Roussillon, i, p. 500, t. 61, f. 1–3; t. 62, f. 5.

In sculpture this species is strikingly different from the other *Leptochitons*, and in fact from all other Chitons. The lateral areas and front valve are strongly terraced, the latter being compared by Carpenter to a circular flight of rounded steps.

The Atlantic specimens are always larger than those from the Mediterranean, the measurements *first* given above being taken from an Ocean example, the second measurements from an Italian specimen.

It is the type of Risso's genus *Lepidopleurus*.

Section *Deshayesiella* Carpenter, 1878.

Deshayesiella Carpenter *mss.*, p. 10.—Dall, Proc. U. S. Nat. Mus., 1878, p. 314; *l.c.* 1882, p. 286.—Haddon, 'Challenger' Polyplacophora, p. 9.

Shell elongated; valves curved, somewhat beaked; umbo flattened; no insertion plates; sutural plates triangular; girdle spiculose.

Differs from *Leptochiton* not only in its hairy girdle but also in its flattened umbo and its valves, which are somewhat thrown forward, forming a decided transition toward some of the palæozoic forms. (*Cpr.*)

L. curvatus Carpenter, n. sp. Pl. 4, figs. 78, 79, 80, 81.

Shell rather elongated, whitish-ashen, planate; dorsal ridge rounded; umbo central, flat; valves with pointed apices, all curved; the interior of the posterior part of each valve much scooped out. Jugal area broadly V-shaped, *quasi* reticulated, the lines of pustules parallel in the middle, diverging at the sides, interstices punctate. Central areas with longitudinal distant, beaded lines, 8 to 10 on each side, tending toward the jugum forward, interstices decussated. Lateral areas somewhat swollen, expanded, but scarcely defined by a line from the central areas; coarsely, irregularly granose, and concentrically waved.

Inside: insertion plates absent, the position of them flat; sinus broad, following the curvature of the valve.

Girdle delicate, clothed with small scattered spines, occasionally larger, and chaffy scales. (*Cpr.*)

Length 14, breadth 6½ mill.; div. 120°.

Okosiri, Japan (A. Adams).

Leptochiton (*Deshayesiella*) *curvatus* Cpr., DALL, Proc. U. S. Nat. Mus., 1878, p. 314 (name and generic characters only).—*Deshayesiella curvata Cpr. MS.* p. 10.

This shell externally looks very much like an *Acanthochiton* without the pore bunches, of which there is no trace. The planed off parts inside the apices are unusually large. (*Cpr.*)

Genus II. HANLEYA Gray, 1857.

Hanleya GRAY, Guide Syst. Dist. Moll. B. M., p. 186, type "*H. debilis* Gray=*Chiton hanleyi* Thorpe."—*Hanleyia* DALL, and *Hanleia* of CARPENTER, *MS.*

Anterior valve having an insertion plate without slits, but roughened; intermediate and posterior valves having no insertion plates; eaves small; girdle with fine spines; no girdle pores.

This genus differs from *Leptochiton* and *Deshayesiella* in possessing an insertion plate upon the anterior valve. It differs from *Hemiarthrum* and *Microplax* in having no insertion plates upon the intermediate and posterior valves, and in lacking girdle pores.

In Dr. Gray's original generic diagnosis, the girdle is said to have pores furnished with tufts of bristles. This has proved to be an error, the statement evidently having been based upon a specimen in which the girdle was transversely wrinkled, throwing the bristles into close groups.

H. HANLEYI Bean. Pl. 3, figs. 71–79.

Shell oblong, convex, the lateral slopes nearly straight, the dorsal ridge rather angular. Sculpture consisting of numerous rounded tubercles, arranged in longitudinal rows on the central areas, the series of tubercles finer and closer upon the jugum; head plate and lateral areas having coarser rather irregular tubercles. The lateral areas are not raised. The mucro is median, rather elevated.

The plates of insertion of posterior and intermediate valves are obsolete, edges roughened; anterior valve having a short, acute insertion plate, outwardly rugose-sulcate, the sulci indenting, but scarcely slitting the margin. Sutural plates moderate; sinus very wide, denticulated by the sculpture of the outside. Eaves very small.

Girdle narrow, beset with numerous short and longer horn-colored spicules. Length 10, breadth 5 mill., sometimes larger.

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British seas northward; Scandinavia; Mageroe, near North Cape, in 25–300 fms.; Stellwagen Bank, Massachusetts Bay, in 38 fms.

Chiton hanleyi Bean, suppl. to Thorpe's Brit. Mar. Conch. p. 263, f. 57, 1844.—Forbes and Hanley, Hist. Brit. Moll. ii, p. 398, t. 62, f. 2.—Jeffr., Brit. Conch. iii, p. 215; v, p. 198, t. 55, f. s.—Sars, Moll. Reg. Arct. Norv. p. 109, t. 7, f. 5.—*Hanleia hanleyi* Bean, Cpr. *mss.* p. 8.—*Hanleya debilis* Gray, Guide, p. 186, 1857.—*Hanleyia debilis* Gray, Dall, Proc. U. S. Nat. Mus. 1878, p. 319.—*? Chiton nagelfar* Loven, Ind. Moll., p. 26.

This species has been reported from Palermo by Monterosato (Jour. de Conch. 1878, p. 147).

Var. abyssorum M. Sars. Pl. 4, figs. 74, 75, 76, 77.

Closely allied to *H. hanleyi*, but more than double the size, having the girdle wider and thicker, spicules shorter; shell narrower, with less distinct sculpture. Pale brown, the girdle flesh-brown. Length 34 mill. (*Sars.*)

Bergen, Norway, 150–200 fms.

Ch. abyssorum M. Sars, G. O. Sars, Moll. Reg. Arct. Norv. p. 109, t. 7, f. 4; t. 34, f. 3.

H. mendicaria Mighels & Adams. Pl. 4, figs. 82, 83, 84, 85.

Shell oblong-oval, not much elevated, dorsal ridge obtuse, lateral slopes flattened; ashen-white, the entire surface granulated, granules closely crowded, forming longitudinal series, about 20 on each side; lateral areas hardly defined, irregularly granulated, the granules larger. Jugum scarcely defined, broadly vaulted. Mucro low or flat, central.

Interior having a solid, rather acute, but scarcely fissured insertion plate to the anterior valve; none upon the central and posterior valves. Sutural plates large, subtriangular; sinus simple, wide, scarcely laminate. Eaves wide. Girdle wide, solid, leathery, very finely spiculate, the spicules glassy, here and there crowded; no pores.

Gills posterior, about 15 on each side.

Length 15, breadth 8¾ mill.; divergence 123°.

Length 27, breadth 15 mill.; divergence 108°. (*Cpr.*)

Casco Bay, Portland Harbor and Grand Manan, Maine.

Chiton mendicarius M. & A., Bost. Journ. N. H. iv, p. 42, t. 4, f. 8, 1842.—Gould, Invert. of Mass., Binney's Edit., p. 263, f. 526.—*Chiton (Acanthopleura) mendicarius* Migh., Jeffr., P. Z. S. 1882,

p. 667.—*Hanleyia mendicaria* Cpr., N. Eng. Chitons, Ann. Mag. N. H. (4) xiii, p. 121 ; *MS.*, p. 9, 10.—Dall, Proc. U. S. Nat. Mus. 1878, p. 319.

H. tropicalis Dall. Pl. 6, figs. 12–18.

Chiton about 10·0 mm. in length and 5·0 mm. in width, with the usual characters of the genus, *i. e.*, anterior valve with an unslit insertion plate, other valves without even the plates; back with an angle of about 90°. Girdle (fig. 13) in the dried specimens, thin, narrow, covered with close-set, white, glassy, slender spines (1·0–1·5 mm. in length) above, and below with similar but much shorter ones. Anterior valve with a well-marked mucro, from which proceed concentric striæ of growth, and in front of which the valve is a little concave; sculpture of little less tesselated flattened nodules radiating from the mucro, above which are irregularly distributed small, opaque, white pustular bubbles of shelly matter looking like attached grains of coral sand; posterior valve smaller, flatter, with similar sculpture, but the pustules take on a decidedly cylindrical shape and are elongated, looking like the stalks of decapitated mushrooms; this arrangement is still more marked on the posterior lateral areas of the intermediate valves, the anterior lateral areas also exhibit (less prominently), but with an obliquely anteroposterior radiation, while the former have it more entirely lateral from the mucrones; dorsal areas with the tesselated sculpture alone, arranged longitudinally. Color entirely white.

Sand Key, Florida, in 128 fms.

Hanleyia tropicalis Dall, Bull. Mus. Comp. Zool. ix, p. 53, 1881 ; 'Blake' Gastrop. p. 415, t. 26, f. 8c, 8d ; Bull. U. S. Nat. Mus. No. 37, p. 172, t. 26, f. 8c, 8d.

Genus III. HEMIARTHRUM Carpenter, 1876.

Hemiarthrum Cpr., in Dall's Moll. of Kerguelen I., Bull. U. S. Nat. Mus. ii, 1876, p. 44.

Head and tail valves having smooth, unslit insertion plates, the intermediate plates lacking them. Eaves minute. Sinus broad and spongy. Girdle solid, downy, poriferous, the lateral tufts small. Gills short.

Differs from all the preceding genera in having both head and tail valves provided with insertion plates, and in the poriferous girdle.

H. SETULOSUM Carpenter. Pl. 5, figs. 89–100; 1–8.

The color of the shell is a uniform warm dark brown, and the girdle is chestnut brown, with a pale crenulated border round the margin of the valves. In each of the dark triangular bays between the valves is a small tuft of short white spicular scales, and there are six similar tufts round the anterior border of the first valve. The anterior and posterior valves and the lateral areas of the intermediate valves are marked by concentric lines of growth, otherwise the latter are scarcely discernible. The jugum is very gently rounded, so that the pleura are slightly depressed. The unslit insertion plate of the anterior and posterior valves is shown in figs. 90, 94, and 4, 5, 6. The girdle (fig. 98) is thick and soft, with a few minute scattered scales. There is a distinct fringe of reddish brown elongated striated scales round the margin. The scales forming the tufts are stout, and white in color. Carpenter describes the anterior tufts as about four in number; in my specimen there are six anterior tufts. Evidently Carpenter was not quite satisfied on this point, as in all other Chitons which possess tufts, only four are present; and, consequently, that number might be expected to occur in this species also. The head lappets are rather large, and the anus is on a large rounded papilla. The longitudinal band on the under side of the girdle (*veil* of Carpenter) is produced into flaps at the posterior extremity.

The gills (pl. 5, figs. 1, 99, 100, 7), form a short posterior row, and appear to be about six in number; they decrease in size anteriorly.

Length 9 mm.; breadth 4 mm.; side of valves meet at an angle of about 115°. (*Haddon.*)

Length 13, width 7 mill. (*Cpr.*)

Kerguelen Island, on stones at low water (Kidder); *and Royal Sound on shore* ('Challenger'); *South Georgia* (Pfflr).

Hemiarthrum setulosum CARPENTER *MS.*, p. 13.—DALL, Bull. U. S. Nat. Mus. ii, 1876, p. 44.—HADDON, 'Challenger' Polyplacophora, p. 14, t. 1, f. 4; t. 2, f. 4a-l.—MARTENS and PFEFFER, Jahrb. der Hamburgischen Wissenschaftlichen Austalten iii, p. 108, t. 3, f. 4, 1886.

The specimens from S. Georgia were much eroded; they measured about 8–11 mill., and were when alive, "brown-black almost black." One of these is figured on pl. 5, figs. 1, 2, 3.

This shell, externally, resembles some of the coarse, ill-defined Acanthochitons. The girdle, however, is narrower and smoother than in that genus, and the pores so extremely minute that in a dry specimen they would escape attention. Within, however, the features are entirely new though not unexpected. It forms a transition between Hanleya (mendicaria) and the articulate chitons. A single unslit lamina surrounds both the terminal valves, projecting far beyond the external layer. In the posterior plate this is continued forward to form part of the sutural laminæ. These in all the valves slope off both toward the middle and toward the sides, so as to take the place of the ordinary side-laminæ, which here do not exist.

Genus IV. MICROPLAX Adams & Angas, 1864.

Microplax H. Ad. & Ang., Proc. Zool. Soc. 1864, p. 194, type *M. grayi* Ad. & Ang.—Carpenter *MS.*, p. 12.

Insertion plates smooth and thin, present in all the valves. Sutural plates obsolete, the sinus extremely shallow. Girdle thin, horny, most minutely granulous. Valves largely concealed in the girdle, the exposed portions small and separated.

In the present genus a small portion only of each valve is exposed; and the sutural plates and sinus are obsolete. No other Chiton having unslit insertion plates approaches this remarkable group.

M. grayi Adams and Angas. Pl. 6, figs. 9, 10, 11.

Shell elongated, convex, brown; exposed portion of the valves minute, wide heart-shaped, carinated, strongly granulated, the intervals between the exposed parts of the valves about as long as the latter. Lateral areas defined by a distinct rib. Girdle moderate, corneous, smooth (*A.* and *A*). Length 13, width 5 mill.

Sydney Harbor, Australia, under stones at low water.

Microplax grayi H. Ad. and Ang., P. Z. S. 1864, p. 194, *l. c.* 1865, p. 58, t. 11, f. 16.—Angas, P. Z. S. 1867, p. 224.—Carpenter *MS.*, p. 12.

The figures given were drawn by Mr. E. A. Smith from the type specimen.

Carpenter's notes upon the unique specimen in coll. H. Adams are as follows: It is quite transparent, looking like thin horn. There are very slight overlappings of the valves, corresponding to

the sutural laminæ, but no slits at all are to be seen. The laminæ are very square, not wavy as in the other covered species. There is a very slight indication of riblets or striæ continuing from the diagonal rib down to the edge of the lamina, but I cannot see the least indication of nicks or lobes at the edge. The sutural laminæ are extremely slight, projecting over each other about to the line of the mucro, with the very slightest sinus in the middle between them.

The front valve is horse-shoe shaped, with flat base, mucro a little removed from the margin. It is nearly smooth at the mucro, becoming gradually more granulose. The whole color is a greenish pink.

The intermediate valves all point forward; their mucrones in no case touch the posterior edges; two smooth, diagonal ribs, curved forwards, separate the lateral and central areas, both of which are granulose.

The posterior valve has the mucro a little anterior, the two oblique ribs curving backwards.

It will be noted that the umbo or mucro in the posterior valve is directed forward, whilst in the other valves it is, as usual, directed backwards.

The divergence is 76°, very elevated. The exposed part of the valves measure about $1\frac{1}{2} \times 1\frac{3}{4}$ mill. The girdle is everywhere minutely granular—too minutely to be shown in the illustration.

Family *CHITONIDÆ.*

=*Ischnoidea* + *Lophyroidea* + *Acanthoidea* of CARPENTER.—*Ischnochitonidæ, Lophyridæ* and *Acanthopleuridæ* DALL, Blake Gastropoda, p. 415, 416.—*Lophyochitonidæ, Chætochitonidæ* (part), and *Chitonidæ* ROCHEBRUNE, Miss. Sci. du Cap Horn, vi, Zool., p. 131–143, 1889.—*Chiton* L., FISCHER, Manual, p. 879.

Chitons in which all of the valves possess insertion-plates slit into teeth; the insertion-plate of the tail valve similar to that of the head valve. Eaves developed.

The conclusion has been forced upon me that the three divisions *B, Ischnoidea, C, Lophyroidea, D, Acanthoidea* of Carpenter's arrangement cannot be separated by sufficiently definite characters to give them the rank of *families.* The Ischnoidea blend with the *Lophyroidea* through certain species of *Chætopleura, Tonicella* and *Tonicia;* and the connection with those *Acanthoidea* having Ischnoid insertion plates is even closer. It is by no means certain that the *Acanthoidea* constitute a natural group; the portion having pectinated insertion plates may prove more closely allied to the true Chitons (Lophyroidea), whilst those with sharp, smooth insertion plates would hold a like relation to the *Ischnoidea.* It is, in fact, not an easy matter to decide whether such genera as *Callistochiton* and *Pallochiton* belong to the Ischnoid or the Acanthoid series, Carpenter referring them to the former, whilst my own studies cause me to place them in the last named group.

In the present work I have concluded to recognize Carpenter's three divisions as *subfamilies,* believing it better to retain a classification admitted to be faulty than to institute radical changes which I am at present unable to place upon an indisputable basis. The regular Chitons having slit insertion plates may therefore be divided into the following three

Subfamilies:

Subfamily ISCHNOCHITONINÆ. Insertion plates smooth or nearly so, sharp, slit into teeth, which project outward on all of the valves.

Subfamily CHITONINÆ. Insertion plates finely pectinated, blunt-edged, the teeth all projecting outward.

Subfamily ACANTHOPLEURINÆ. Insertion plates smooth and acute, or pectinated and obtuse; teeth of the posterior valve distinctly directed forward, not outward.

Subfamily Ischnochitoninæ.

Ischnoidea Cpr., Table of Regular Chitons, and Dall, Proc. U. S. Nat. Mus. 1882, p. 283, (in part; Genera 19–24 excluded).—*Ischnochitonidæ* Dall, 'Blake' Gastrop. p. 415, 1889.

I have above given some of the reasons which induce me to consider this group as a subfamily rather than a family. I am wholly disposed to believe that the subfamily as here constituted, is rather artificial; and some of the genera may require consolidation. The relation existing between *Chætopleura* and *Tonicia* especially calls for investigation; and there are some forms (section *Cyanoplax*) which seem to bridge the gap between *Chætopleura* and *Tonicella*.

Synopsis of Genera of Ischnochitoninæ.

Genus V. LEPTOPLAX Cpr.

Valves thin, *partly immersed* in the thin *smooth* girdle; *insertion plates acute, having few slits.* Umbo of posterior valve median.

Genus VI. SPONGIOCHITON Cpr.

Valves *partly immersed.* Insertion plates acute; umbo of posterior valve median. Girdle *spongy,* having chaffy scales and hairlets, and *produced forward.*

Genus VII. CHÆTOPLEURA Shuttlw.

Valves exposed; insertion plates smooth or obsoletely grooved outside; *eaves solid;* umbo of posterior valve central or anterior. *Girdle leathery, more or less hairy.*

Genus VIII. TONICELLA Cpr.

Valves exposed; insertion plates smooth or slightly grooved outside; eaves spongy; umbo of posterior valve anterior. *Girdle leathery and smooth,* without scales or hairs.

Genus IX. SCHIZOPLAX Dall.

Valves exposed, and similar to those of *Tonicella* except that the intermediate valves have a *median longitudinal slit filled with cartilage. Eaves very spongy.* Girdle leathery, as in *Tonicella.*

Genus X. CALLOCHITON Gray.

Valves exposed; insertion plates cut into *numerous* teeth rising from very *spongy eaves*, the teeth more or less *buttressed* at the outside edges. *Sutural-plates continuous across the very shallow median sinus.* Girdle typically covered with fine compact diamond-shaped scales; but in the subgenus *Stereochiton* sparsely downy, frequently naked by erosion.

Genus XI. ISCHNOCHITON Gray.

Valves exposed; insertion plates sharp, smooth; eaves not spongy, or rarely so. Umbo of posterior valve varying from posterior to anterior. Girdle covered with imbricating scales.

Genus V. LEPTOPLAX Carpenter, 1882.

Leptoplax Cpr. *MS.*, and Table of Regular Chitons, 1871.—Dall, Proc. U. S. Nat. Mus. 1882, p. 286. Type *C. coärctatus* Sby.

Valves thin, partly immersed in the thin, smooth girdle. Insertion plates acute, with few slits, but regular. Sinus scarcely toothed; mucro median. (*Cpr.*)

The prominent characters of this genus are, (1) valves partly covered by a thin extension of the girdle, (2) girdle smooth, as in Tonicella, (3) insertion plates long, with few slits. The gills are unknown.

L. coarctatus Sowerby. Pl. 11, figs. 38, 39.

Shell elongated, very delicate, little elevated, the dorsal ridge acute; greenish-ashen or reddish-olive. Valves of the normal form, but two-thirds covered by a thin cuticle continued from the girdle. Exposed portion of the valves flask-shaped, the jugular area smooth, subelevated, having longitudinal rows of points; central areas and end valves having large pustules, close and somewhat radiately placed, about 20 on each side in a young specimen, 100 in an adult; lateral areas scarcely defined; mucro slightly behind the center, rather elevated. Interior: Plates of insertion very long, *rose-tinted*, here and there delicately striated outside. Slits small, in the posterior valve 6, posteriorly situated; central valves 1, anterior valves 4, having shallow grooves running up to the eaves. Sinus

moderate, indented by the sculpture of the outside. Girdle very thin, rather expanded, smooth. (*Cpr.*)

Length 13½, breadth 7¼ mill.; divergence 120°.

Island of Bohol, Philippines.

Chiton coarctatus SOWERBY, P. Z. S. 1841, p. 62.—REEVE, Conch. Icon., t. 20, f. 127.—*Leptoplax coarctatus* CPR. *MS.*, and *Lept. rubrotincta* CPR. *MS. olim.*

This might be regarded as an extremely delicate Katherina, but that the valves are thrown forward and the tail-plate is Ischnochitonoid rather than Mopaloid. It differs from Fannia as Ischnochiton does from Chiton, in the extreme thinness and general smoothness of the sharp teeth and in the non-dentition of the sinus. I have seen no other regular Chiton in which the insertion plates are tinted, the head valve having only four slits, and the tail valve with so long a lamina, unfissured, at the anterior sides. (*Cpr.*)

Carpenter at first described this form under the name *rubrotincta* but he discovered its identity with *C. coarctatus* by an examination of the type of the latter. The sculpture varies much; sometimes there are a few large grains, sometimes many smaller ones.

Genus VI. SPONGIOCHITON Carpenter.

Spongiochiton CPR., Table of Regular Chitons, 1873.—DALL, Proc. U. S. Nat. Mus. 1882, p. 272, 283, 286, 289, 290.

Valves partly immersed; insertion plates acute, Ischnoid; sinus large, smooth; mucro median, flat; girdle spongy, produced forward. (*Cpr.*)

S. PRODUCTUS Carpenter, n. sp.

Shell oval, the valves immersed two-fifths of their width; exposed portion rubicund, flat, the jugum arcuate, paler. Lateral areas scarcely defined. Entire surface sculptured with prominent pebbles, worn at the jugum. Mucro submedian, flat.

Interior: posterior valve with 6, central valve 1, anterior valve 5 slits; teeth long, acute, scarcely serrate; sinus wide, smooth, extremely deep. Eaves narrow, scarcely grooved.

Girdle produced in front, spongy, sparsely covered with chaffy scales and translucent hairlets.

Length 25, breadth 16¼ mill.; divergence 130°. (*Cpr.*)

New Zealand (Mus. Cum. no. 50).

This very peculiar shell resembles Mopalia blainvillei in mantle and mucro; and Nuttallina in the long, smooth plates, separated by a deep, not laminated sinus. The side slits, however, are single and deep instead of duplicate and angular, as in that genus; the posterior plates are not thrown forward nor waved as in Mopalia. Leaving out of view the anterior prolongation of the mantle, which is a variable character even among Mopalia, it may be regarded as a partially covered Tonicella. The slits are abnormally few, as in Leptoplax. But for the characters of the tail plate I should have considered it intermediate between Mopalia and Katherina. (*Cpr.*)

Genus VII. CHÆTOPLEURA Shuttleworth, 1853.

Chætopleura Shuttlw., Diagn. neuer Moll. no. 4, über den Bau der Chitoniden, etc., in Bern. Mittheil. p. 66, June, 1853 (=Acanthopleura Gray, ex parte).—*Chætopleura* Cpr. *MS.* and Dall, Proc. U. S. Nat. Mus. 1878, p. 329, type *C. peruviana* Lam.—*Acanthopleura*, Gray, Guide Moll. B. M. p. 183.

Valves as in Ischnochiton; *eaves solid;* girdle leathery, more or less hairy; gills extending almost or entirely to the front end of the foot.

The present group seems to me to stand naturally on the confines of the Ischnochitonoid series, having decided relations to the true Chitons and especially to *Tonicia.*

Carpenter made a subgenus, *Maugerella*, under *Chætopleura*, for a Radsioid Californian form, which I have excluded from the genus, as its affinities are with the Radsioid Ischnochitons. The following able discussion of this genus is from Carpenter's *MS.*:

Shuttleworth, in distinguishing this genus from Acanthopleura by the mantle characters only, does not seem to have observed the coordinate differences in the hind valve and the insertion plates. Messrs Adams united to this genus Eudoxochiton and Craspedochiton which do not belong to the same section. Gray, in his "Guide," p. 183, ignores the genera of Shuttleworth, but preserves the distinction between Chætopleura and Acanthopleura. Most unfortunately, however, he chooses to keep the name Acanthopleura for Chætopleura of Shuttleworth and Add., and makes a fresh name *Maugeria* for the restricted Acanthopleura of Shuttleworth and Add. Even if Shuttleworth had been unwise in his mode of division, he would have been entitled to precedence; but fortunately he kept Acanthopleura for the first section of Guilding's group,

Zool. Journ. v, p. 28, represented by Chiton spinosus Sby. The West Indian species belonging to this section (A. picea) must have been familiar to him and given rise to the "zona crassa carnosa" of his diagnosis, with which Chætopleura does not accord. The latter as represented by C. peruvianus, forms only the sixth among seven subgeneric sections into which Guilding divided his genus. Shuttleworth and Adams place the hairy Chitons in Chætopleura and those with shelly bristles in Acanthopleura.

The distinction is obvious as between peruviana and picea, but not so in the case of many species when the bristles are corneous but with more or less of shelly matter in their substance. There are also many species in which the hairs are shortened and flattened into chaffy scales and others in which hairs grow irregularly in the midst of a spongy or chaffy mass. Gray, moreover, assigns "shelly bristles" to the peruviana group and "shelly spines or bristles" to the picea group. To the first, however, are assigned thin, to the second thick valves. Both are described as having the insertion plates pectinated; but as being "regular well developed" in peruviana, but "narrow, rather irregular" in picea. This last results from what seems to me the essential difference. Acanthopleura is hunch-backed on the tail plate, with the insertion plates thrown forward and grooved outside; while Chætopleura has the normal tail plate of Chiton and Ischnochiton and agrees with the latter genus in having the insertion plates not pectinated and nearly smooth. The transition forms from the densely pilose peruviana to the smooth mantle of Tonicella are so gradual that the latter might rank as a subgenus under Chætopleura were it not that the gills in this genus are represented as elongate. (*Cpr.*)

Chætopleura should be compared with the Lophyroid genus *Tonicia*, which has similar ambient gills and solid eaves, and frequently has the teeth scarcely more pectinated than in the larger Chætopleuras.

The genus consists of several groups of species. (1) Typical forms, rather large, and having very delicate sculpture; and (2) Group of *C. gemmea*, having the lateral areas strongly raised and coarsely sculptured, the central areas also sculptured.

(1). *Group of C. peruviana.*

C. PERUVIANA Lamarck. Pl. 12, figs. 42–46.

Shell oval, depressed, dull ash colored, the girdle clothed with long, stiff, crisp black hair, a fringe of which also projects from each

suture. The valves are minutely sculptured with very minute granules in lines which diverge slightly at the jugum, more upon the sides of the central areas, divaricate on the border between central and lateral areas, and are radiating upon the lateral areas and terminal valves. The umbo of the tail valve is low, somewhat anterior.

Interior white with a brown stain at the back edge of each valve. Anterior valve having long insertion plates which are distinctly crenulated outside, and have 9–10 slits, central valves with 1 slit, post. valve with 7–9 slits. Sutural plates very broad, connected across the sinus by a narrow plate; eaves narrow, short, not spongy.

Length 38, breadth 26 mill.

Lima, Peru; Chili; to Cape Horn.

Chiton peruvianus Lmk., An. s. Vert. vi, p. 321; ed. Dh., vii, p. 491.—Barnes, Amer. Jour. Sci. vii, p. 10, t. 3, f. 2.—Sowb., Conch. Illustr. f. 44.—Reeve Conch. Icon. f. 50.—*Chaetopleura peruviana* Lm., Shuttlw., Diagn. n. Moll. nr. 4, p. 67.—Rochebr., Moll. Cap Horn, p. 135.—*Acanthopleura peruviana* Lm., Tap. Can., Viag. Magenta, p. 77.

This form is readily known by its girdle covering and sutural fringes of long black hairs. The sutural plates are strongly developed, slightly recalling *Leptoplax*. The hair is crisp and coarse, like that of a horse's tail. The gills extend forward to the head.

C. hennahi Gray. Pl. 12, figs. 47, 48, 49; pl. 17, fig. 39.

Shell oval, rather depressed, dorsal ridge obtuse, side slopes nearly straight. Color variable, but generally either reddish-brown marked with red, or greenish-white marked with brown; surface smooth to the naked eye. Girdle leathery, covered with short hairs, which may readily be rubbed off.

The median valves are about four times as wide as long; the lateral areas are only weakly indicated; the tail valve is depressed, with the slightly prominent umbo in front of the middle, the posterior slope concave. The sculpture consists of closely beaded fine separated threads, which are longitudinal on the central, radiating on the lateral areas and end valves; under this may be seen an excessively fine, close shagreening of the whole surface.

Inside white, each valve marked with brown under the beaks. Sutural plates of equal width from the outer angle of the valve to the rather shallow sinus. Ant. valve having 13, central valves 1, post.

valve 13 slits, (Carpenter gives: ant. v. 10, centr. 1, post. 9–12 slits). Teeth sharp, those of the head valve prominently grooved outside. Eaves narrow and short, grooved just above the teeth, not spongy.

Girdle (pl. 17, fig. 39) granulated, sparsely clothed with stiff white spinelets.

Gills continuous to the head, as in *C. peruviana.*

Length 43, breadth 28 mill.

Callao Peru, on Pectens, in 5–7 fms.

Ch. hennahi Gray Spicil. Zool. p. 6, July, 1828.—Sowb., Conch. Illustr. f. 1, 33.—Reeve, Conch. Icon. t. 7, f. 37, and pl. 23, lower central figure.

This species is closely allied to *C. peruviana* in form of the valves and sculpture. The girdle hairs are short, deciduous, and when retained they are disposed to lie in bunches. The front teeth are decidedly grooved outside, in old specimens resembling those of *Tonicia fulva.*

C. nobilis Reeve. Pl. 14, fig. 80.

Shell ovate, smooth or very closely marked throughout with minute raised dots; lateral areas faintly radiately grooved. Reddish chocolate-brown, unspotted; ligament horny, beset with very short, hard bristles (*Rve.*)

Habitat unknown.

Chiton nobilis "Gray," Reeve, Conch. Icon. t. 21, f. 139, May, 1847. Not *Chiton nobilis* Gray.—*Chætopleura nobilis* Rv., Cpr. *MS.*

Carpenter further describes the type specimen: mucro median little elevated; valves rounded at the sides. Interior: post. valve with 9, ant. 11, centr. 1 slit. Teeth acute; eaves small; sinus small, deep, planate, smooth. Girdle leathery, pale brown, sparsely and irregularly beset with very short, solid, black, somewhat scale-like bristles.

The above is written from the type specimen which Rve. described as the *C. nobilis* of Gray, and which Mr. Adams most kindly submitted to my examination. This shell proves to be a normal Chætopleura: while *Eudoxochiton nobilis* Gray, belongs to the Lophyroid section. Lest the confusion should be repeated, the following notes on the sculpture of *C. nobilis* Rve. may be useful.

Central areas having subparallel or slightly radiating lines of granules, about 20 on each side. Lateral areas scarcely defined, having about 10 irregular radiating lines, the ant. valve having 50, post. valve 40 such lines. Entire surface most minutely punctate.

This species must not be mistaken for the *externally* very similar Eudoxochiton.

(2) *Group of C. gemmea.*

C. GEMMEA Carpenter, n. sp. Pl. 13, figs. 69–74.

Shell oblong, *elevated*, *red*, olive-ashen or yellow; umbo of tail valve *depressed*, situated behind the middle. Lateral areas decidedly raised, coarsely radiately tuberculate; central areas having longitudinal beaded liræ. Girdle narrow, leathery, sparsely clothed with short hyaline hairs, which are readily rubbed off.

The valves are elevated. The central areas are sculptured with elevated, distinctly beaded longitudinal cords, about 15 in number on each side; they became very small or subobsolete upon the jugum. The lateral areas are strongly differentiated; they have 5 to 7 radiating rows of distinct, clear-cut tubercles. The mucro does not rise above the general level of the posterior valve.

Inside often tinted with red, often having a red or black spot at the jugal sinus. Sutural plates well-rounded, the sinus rather deep and angular. Anterior valve having 9–12, median 1, posterior valve 7–8 slits. Teeth rather blunt and stout; eaves not spongy, rather wide.

Length 16½, breadth 8 mill.

Monterey, California.

Chætopleura gemmea CPR. *MS.*

This beautiful little species is excessively similar to *Ischnochiton mertensii* in sculpture, but the smaller size, narrower form, and especially the short, transparent hairs of the girdle, distinguish it.

C. BULLATA Carpenter.

Shell subovate, elevated, olivaceous; intermediate valves ornamented with strong rows of pustules; lateral areas very narrow, tuberculate, sometimes pustulate. Central areas having lines of tubercles, about 7 on each side, and perpendicular lines, interstices granulated. End valves having about 11 radiating rows of pustules; mucro somewhat conspicuous. Girdle wide, having small hairlets. Sutural

plates triangulate; sinus deep; margins of the valves simple, the median having 1, the terminal valves about 7 slits. (*Cpr.*)

Length 4¼, breadth 3, alt. ⅔ mill; divergence 110°.

Mazatlan, on Spondylus calcifer.

Lepidopleurus bullatus Cpr., Mazat. Catal. p. 195.—*Chætopleura bullata* Cpr. *MS.*—*L. bullatus var. calciferus* Cpr., *l. c.* p. 196.

One fresh specimen (somewhat crushed in extraction) and a few perfect valves were found of this species, which is characterized by the very strong row of tubercles, (like pebbles) which lie on the diagonal line; by the rows of somewhat strong tubercles on the central area, running perpendicularly from the diagonal towards the jugum and the granules over the whole surface, somewhat corrugated on the jugum. The internal plates of all the valves have an external projection from the outer surface, as in *L. sanguineus*.

Carpenter describes a larger specimen in *ms.* as follows: Mucro median, scarcely elevated. Vermilion and olive, very irregularly, vividly maculated. Interior: posterior valve with 9, central valves 1, anterior valve 11 slits. Teeth acute. Eaves projecting, pectinated by the sculpture. Sinus moderate, high, laminate. Girdle smooth, ornamented with sparse hairlets. Gills subambient, scarcely reaching the head. Abedhas Reefs. (Mus. Yale College). This specimen is about 15 mill. long, 6¼ broad, divergence 125°. It agrees in most respects with the very young shell described in Maz. Catal., but is much longer in proportion.

Var. CALCIFERA Cpr.

Lateral areas tuberculate, without pustules; diagonal line pebbled; central areas with lines of tubercles irregular, tubercles smaller. Hairs of the girdle larger, very close.

Mazatlan.

C. BEANII Carpenter.

Shell ovate, elevated, brown-olive or maculated with whitish and bluish. Intermediate valves strongly mucronate, interstices curved, margins somewhat rounded. Posterior valve depressed, excavated, the mucro small, superior; jugal and lateral areas indistinct; surface covered with granules and ornamented with small close points. Sutural plates large, curved; sinus flat; insertion plates acute, the intermediate valves with 1, terminal valves 10 slits. Girdle hairy, spines small, erect, flat.

Length 5¾, breadth 3¼, alt. 1 mill.; divergence 110°.

Mazatlan.

? Lepidopleurus beanii Cpr., Maz. Catal. p. 197.—*Chætopleura beanii* Cpr. *MS.*

Differs from L. Macandrei in being longer, with the valves mucronated and rounded at the extremities, the posterior being hollowed out and the rest much elevated, without conspicuous middle portion or lateral areas. The only perfect specimen found (on Acmæa fascicularis) displays no trace of solid scales. The account of the interior is taken from a large central and small anterior valve supposed to belong to this species from their agreement in other respects.

C. flavescens Carpenter. *Unfigured.*

Shell ovate, much depressed, yellow, spotted with orange. Valves wide, somewhat rounded at the margins, the interstices curved, strongly mucronate. Lateral areas and jugum indistinct; mucro small, superior. Entire surface furnished with close granules, scarcely punctulate; girdle thick, nearly smooth, furnished at the margin with delicate erect flattened spines. Sutural plates large, arcuate; sinus large. End valves with about 10, intermediate valves 1 slit. Length 4, breadth $2\frac{3}{4}$, alt. $\frac{3}{4}$ mill.; divergence 150°.

Mazatlan, on shells.

Chiton flavescens Carpenter, Maz. Cat. p. 198.

This is the least uncommon of the small Chitons, six specimens having been found of it. It is distinguished by its yellow color, great depression and small strong mantle margin, without covering, except at the margin where a fine row of transparent flattened hairs may be seen. The smaller lobe on the margins of the inner valves is bounded by two rows of holes which proceed to the jugum. (*Cpr.*)

C. lurida Sowerby. Pl. 12, figs. 53, 54.

Shell oblong, rather elevated, ashen; front valve, lateral areas of intermediate valves and posterior valve coarsely granulose; central areas longitudinally sulcate, threads between the grooves granulose. Length 30, breadth 15 mill. (*Sby.*)

Sta. Elena, W. Colombia, on stones in 5 fms.

Chiton luridus Sowb., P. Z. S. 1832, p. 26; Conch. Illustr. f. 20.—Reeve, Conch. Icon. f. 85.—*Chiton scabriculus* Sowb., P. Z. S. 1832, p. 28; Conch. Illustr. f. 21.—Reeve, t. 15, f. 81.—*Ischnochiton parallelus* Cpr., Ann. and Mag. N. Hist. (3), xiii, p. 314.—*Ischnochiton* (*? var.*) *prasinatus* Cpr., *l. c.*, p. 314.

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To this species Carpenter unites *C. scabriculus* Sowb. (pl. 12, figs. 55, 56) and *Ischnochiton parallelus* Cpr., a figure of which, drawn from a Carpenterian specimen from Cape St. Lucas, is given on pl. 12, fig. 50. It is likely that *C. columbiensis* should be added to the synonymy, as it presents no differential characters of much value.

Var. PARALLELA Cpr. Pl. 12, fig. 50.

The specimen before me of the form *parallelus*, measures 17 by 11 mill. It is rather acutely carinated, the sides slopes nearly straight. There are 17 beaded longitudinal threads on each side of the central areas, and from 6 to 7 rows of separated, rounded, erect tubercles on each lateral area. The lateral areas are decidedly elevated; the mucro is slightly prominent. The girdle has sparsely scattered hyaline short hairs. The gills continue as far as the front end of the foot. The outside is reddish, marbled with darker and white, the girdle dark ashen. The interior is bluish-white.

Cape St. Lucas.

The style of sculpture is the same as in *C. gemmea*, but the shell is much broader than in that species.

Var. PRASINATA Cpr.

Similar to *parallela*, but vivid green; lateral areas irregularly ornamented with series of tubercles. *Cape St. Lucas.*

Var. COLUMBIENSIS Sowerby. Pl. 12, figs. 51, 52.

Shell ovate, a little depressed, ashen; end valves and lateral areas sparsely granulose; central areas longitudinally granose-lineate. (*Sby.*) Length 31, breadth 18½ mill.

Bay of Panama, under stones at low water.

C. columbiensis SOWB., P. Z. S. 1832, p. 58; Conch. Illustr. f. 15.—REEVE, Conch. Icon. f. 82.—*Chætopleura columbiensis* Sby. CPR., *ms.*

Carpenter says: Mucro slightly in front of the middle, subplanate, the posterior part excurved. Interior: posterior valve with 8, anterior valve 9, central 1 slit. Teeth obtuse, scarcely roughened; eaves large; sinus narrow, moderately deep. Girdle leathery, with a few corneous hairlets. . . . One of Colonel Jewett's specimens is of a uniform dark chocolate color, but parts of some of the valves are of a variegated olive.

Of another specimen Cpr. writes: One specimen of the *scabriculus* type. Girdle finely hairy. Red, with dark girdle. On each

side of the central areas there are 16 fine rows of beads, not very much developed; jugular areas not defined; side areas with irregularly scattered grains. Mucro central, depressed.

Length 28, breadth 17 mill.

Carpenter seems disposed to unite to *columbiensis* the species described as *scabriculus* and *luridus*, the former of these two being less, the latter more beaded than the typical *columbiensis*. In case this view is correct, *columbiensis* will fall into the synonymy of *luridus*.

C. ISABELLEI d'Orbigny. Pl. 13, figs. 57, 58.

Shell oblong, brown; back carinated; front valve and lateral areas of the intermediate valves radiately granulate; central areas longitudinally granulose-striate. Length 22 mill. (*Orb.*)

Bay of San Blas, Patagonia.

Chiton isabellei ORB., Voy. dans l'Amér. Mérid. p. 488, t. 65, f. 14–19.—*Tonicia isabellei* ROCHEBR., Cap Horn, p. 138.—*Chætopleura isabellei* CPR. *MS.*

Allied, by its granulated striæ, to *C. peruvianus*, but narrower, more carinated, the girdle smooth. (*Orb.*)

The gills are figured as continuing almost to the front end of the foot. In the absence of any information regarding the insertion plates it is impossible to say whether this species is a *Tonicia* or a *Chætopleura;* if the latter, the girdle is probably not truly smooth. In sculpture it seems near to *columbiensis* and its allies.

C. DIEFFENBACHII Reeve. Pl. 13, figs. 65, 66.

Shell somewhat elongately ovate; valves covered with very minute raised dots; lateral areas scarcely raised; posterior valve umbonated; variegated with red, green and yellow; ligament horny, arenaceous. (*Rve.*)

Newcastle, Australia.

Chiton dieffenbachii RVE., Conch. Icon. t. 22, f. 149; species no. 148.

The locality must be regarded with doubt until confirmed. It may prove to be from Peru, and a synonym or variety of *C. lurida* Sowb. The figure is enlarged.

C. APICULATA Say. Pl. 13, figs. 75–79.

Shell oval, elevated, light buff or ashen, unicolored or having black patches at the sides or on the ridge (sometimes red or purple

in Southern specimens); carinated, the side-slopes nearly straight; central areas having beaded threads, lateral areas and end valves having numerous scattered pustules.

The lateral areas are distinctly defined, raised, and bear numerous erect rounded pustules, *irregularly scattered*, not arranged in rows. The end valves have the same sculpture, but the pustules are more crowded. The central areas have minutely beaded longitudinal threads, from 15 to 20 on each side. The umbo of the posterior valve is in front of the middle, and rendered slightly projecting by the concavity of the slope back of it.

The interior is white or stained with leaden in places. The sutural plates are rounded; sinus moderate but angular. Slits of anterior valve 11, central valves 1, posterior valve 9–11. Teeth slightly crenulated; eaves short, solid.

Girdle narrow, bearing sparsely scattered, transparent, short hairs.

Gills extending almost to the forward end of the foot, 24 branchiæ on each side.

Length 17, breadth 10 mill.

Length 16, breadth 12 mill.

Cape Cod, Massachusetts, to Florida.

Chiton apiculatus Say, Amer. Conch., edit. Binney, p. 231.—Sowb., Conch. Illustr. f. 140.—DeKay, Moll. N. Y. p. 164, t. 10, f. 201, 202.—Gould, Invert. of Mass. (edit. Binney), p. 258, f. 522. —*Chætopleura apiculata* Say, Cpr. Ann. Mag. N. H. (4), xiii, p. 120.—Dall, Proc. U. S. Nat. Mus. 1882, p. 410; Bull. 37, U. S. Nat. Mus., p. 172, t. 51, f. 10.—*Chiton labeculatus* Reeve, Conch. Icon. t. 18, f. 108.

The tubercles of the lateral areas and end valves of this species show a lack of arrangement into radiating rows, which will readily distinguish this from other species.

It is quite commonly distributed along the Atlantic coast of the United States from Nantucket to Florida, and has also been reported from Haiti.

The Northern examples are generally buff or ash colored, sometimes with patches of black; but in a suite before me from Marco, Florida, one specimen is scarlet and another purplish-pink. These southern examples, whilst agreeing with the typical form in sculpture, are smaller and comparatively narrower. (Figs. 78, 79.) A specimen from Anglesea, New Jersey, has the lateral areas and

end valves pink, the central areas buff, and each valve has a triangular black patch at the dorsal ridge. The girdle is alternately buff and pink.

C. CANDISATUS Shuttleworth. *Unfigured.*

Shell elliptical, convex, dull waxen, the back sometimes banded with white; terminal valves having large white granules, which are much elevated, sparsely and somewhat concentrically arranged. Median valves subcarinated, the central areas having smaller whitish granules, arranged in straight necklace-like series, crowding at the umbones; lateral areas conspicuously elevated, having large, remote, irregularly placed granules. Entire surface covered with a very minute, chaffy puncticulation. Girdle narrow, waxen, marbled with *pale brown;* chaffy-pustulose, and having pellucid, corneous white setæ here and there, especially at the insertions of the valves.

Length 8–9, breadth 4½–5 mill.

Guadeloupe, on dead valve of Cardium serratum.

Chiton (*Chætopleura*) *candisatus* SHUTTL., Jour. de Conch. 1856, p. 168.

Apparently closely resembling *C. apiculata* Say, in pattern of sculpture.

C. JANEIRENSIS Gray. Pl. 13, figs. 59, 60.

Shell oblong, elevated, rather narrow; dorsal ridge somewhat angular, olive-ashen or brownish; strongly sculptured, the mucro in front of the middle, rather prominent.

Lateral areas strongly elevated, sculptured with four coarse, granose ribs; anterior valve having 11 to 18 such ribs, usually having a tendency to be in pairs or to split. Central areas having about 12 granose acute threads on each side of the jugum, parallel with it.

Interior white, sutural plates rounded; sinus shallow; anterior valve with 10, median valves 1, posterior valve 9 slits. Teeth solid, eaves wide, solid.

Girdle having a few delicate short hairs.

Length 18, breadth 9 mill.

Gills reaching the neck.

Key West, Florida, to Rio Janeiro, Brazil.

Chiton janeirensis GRAY, Spicil. Zool. p. 6, t. iii, f. 8, 1828.—SOWB., in Zool. Beechey's Voy., t. 40, f. 2.—REEVE, Conch. Icon,

t. 19, f. 116 (not t. 15, f. 81).—Sowb. Conch. Illustr. f. 56.—*Chætopleura janeirensis* Cpr. *MS.*; *C. apparata* and *Callistochiton rufi-costatus* Cpr., *olim.*—*Chætopleura janeirensis* Dall, Bull. 37, U. S. Nat. Mus. p. 172.—*Chiton segmentatus* Reeve, Conch. Icon. t. 23, f. 155.—*Chiton* (*Chætopleura*) *asper* Shuttlw., Jour. de Conchyl. 1856, p. 169.

This species is much elongated, about twice as long as broad. The sculpture of the end valves and lateral areas consists of coarse, nodulous ribs, which are quite unlike the clear-cut pustules of *C. apiculata, gemmea,* etc.

Young specimens have only two or three nodulous ribs on the lateral areas.

The *C. segmentatus* of Reeve (pl. 13, figs. 61, 62) differs in no way from the type.

C. spinulosa Gray. Pl. 13, figs. 63, 64.

Shell ashen, partially tessellated with dark and light at the sutures, and stained with brown on some of the jugular areas. Jugum very acute, elevated. Mucro median, not much raised, the posterior slope very concave. Jugal area not distinct; central areas having about 22 rows of very fine granules on each side of the otherwise smooth areas; lateral areas much raised, having about 10 rows of radiating grains, *separate,* sparse; grains very irregular and sparse on terminal valves.

Interior: Anterior valve with 10, central valves 1, posterior valve 9 slits. Teeth not very sharp but Ischnoid, the posterior slightly rugulose. Sinus smooth, channelled, broad, deep, the projecting jugular sculpture of the outside giving a faint appearance of denticulation. Eaves moderate, not spongy. Interior whitish, with two rays of chestnut.

Length 31, breadth 15½ mill.

Rio Janeiro.

Chiton spinulosus Gray, Spicil. Zool. p. 6, t. 6, f. 7, 7a.—Sowb., Conch. Ill. f. 84, 84a.—Reeve, Conch. Icon. t. 27, f. 90.—*Chætopleura spinulosa* Cpr., *MS.*

It is doubtful whether the *C. spinulosa* of Sowerby, Reeve and Carpenter is the same as the form originally so named by Gray. Carpenter's description, given above, is drawn from a single specimen, which apparently served Reeve for his illustration. This specimen is much injured, having lost its girdle, and some of the

valves and teeth are broken. The figures here given are from Reeve.

C. SOWERBIANA Reeve. Pl. 13, figs. 67, 68.

Shell oblong-ovate, valves having the lateral areas conspicuously elevated, granosely ridged throughout, ridges of the central areas much finer. Dull yellowish-brown, with a triangular whitish spot along the umbonial summit of each valve. Ligament horny. (*Rve.*)

Rio Janeiro.

Chiton janeirensis Gray, REEVE, Conch. Icon. t. 15, f. 80.—*C. sowerbianus* REEVE, *l. c.*, in note under species No. 116, May, 1847. —*Sowerbyi* REEVE, *l. c.*, expl. of pl., detail of sculpture, sp. 80.—*Sowerbyanus* REEVE, *l. c.*, index to Chiton.

Carpenter says: Seems to me a coarse var. of *spinulosa* Gray. Rio Janeiro. Very like *apiculata*, but with more swelling side areas. The sinus represented in the sculptured figure of Reeve is only the part left after the swelling of the sides. With this impression, I did not think it necessary to examine the single specimen in Cuming's collection; but on further examination I thought it might be a distinct species and described it thus: Valves arched; jugum rather rounded; jugular area finely striate. Central areas having about 18 nearly parallel ribs on each side, the interstices decussated between the ribs, which are sharp (not in necklaces). Lateral areas swelling, with 6 to 8 very close rows of coarse granules, intercalating, and no spaces between. In the end valves they go into close radiating rows. Mucro in front of the middle, depressed, the slope behind it very concave. Girdle with very few scattered hairs. Interior: Anterior valve with 9, central 1, posterior 8 slits; teeth sharp, normal; eaves conspicuous, rugulose, but not spongy. Sinus moderate, sharp, deep, channelled.

Length 26½, breadth 13½ mill.

C. ARMILLATA Carpenter, n. sp. *Unfigured.*

Shell subelongate, elevated, the jugum acute; mucro a little in front of the middle; reddish-brown, maculated with darker. Valves quadrate, scarcely apicate; jugal area scarcely defined; central areas having 14 to 20 lines of small granules on each side, the interstices flat. Lateral areas scarcely elevated, having subradiating, distant, sparse granules; entire surface nearly smooth, very minutely punctulate and striatulate under a lens. Interior:

Posterior valve with 9, anterior 9, central 1 slit. Teeth acute; eaves conspicuous; sinus narrow, deep, smooth. Girdle leathery, very minutely downy-scaled and having occasional delicate, corneous hairs. (*Cpr.*) Length 25, breadth 11½ mill.; divergence 100°.

Is. Gorriti (Mus. Cum. No. 34).

One of the specimens is light colored on the jugum of each valve, encircled with a triangular spot. (*Cpr.*)

Genus VIII. TONICELLA Carpenter, 1873.

Tonicella Cpr., Bull. Essex Inst. v, p. 154, 1873, type *C. marmoreus* Fabr.—Dall, Proc. U. S. Nat. Mus. 1878, p. 324.—*Tonicia*, in part of Gray, Adams, *et al.*—*Boreochiton* (part) Sars, Moll. Reg. Arct. Norv. p. 116, 1878.

Valves, sutural plates sinus and teeth as in Ischnochiton, but the eaves are spongy; girdle as in Tonicia, leathery, smooth or nearly so. Gills extending forward from two-thirds to three-fourths the length of the foot.

Distribution, Northern Atlantic and Northern Pacific shores.

This group differs from *Trachydermon*, *Callochiton*, *Ischnochiton*, *Chætopleura*, etc., in its naked, scale-less girdle; from *Stereochiton* in having a single slit in the median insertion plates. It differs from *Tonicia*, to which genus the species of *Tonicella* were formerly referred, in the non-pectinated insertion plates, spongy eaves and shorter gills.

The surface of the valves is smooth, or evenly microscopically granulated.

The essential differences between *Tonicella* and *Chætopleura* seem to be bridged by several species which are intermediate in characters of gills, girdle or both. The former should perhaps rank as a subgenus rather than a genus, as the pattern of sculpturing of the valves, shorter gills and spongy eaves are about all there is to separate the two groups.

Under *Tonicella*, as a subgenus, I include the peculiar type *Cyanoplax*, proposed for the reception of the *C. hartwegii* Cpr. The genus will therefore be divided thus:

Subgenus Tonicella *s. s.*

Teeth rather long; valves nearly smooth; gills shorter than the foot.

Subgenus Cyanoplax Pils.

Teeth stumpy, bi- or tri-lobed; valves granulated; gills ambient.

Subgenus TONICELLA Cpr.

T. MARMOREA Fabricius. Pl. 10, figs. 8–15.

Shell oblong or oval, elevated, rather acutely angular; buff, closely speckled and maculated with dark red, as in *Trachydermon ruber*. *Surface densely, microscopically granulated*, but apparently smooth. Lateral areas not distinct. Valves beaked, umbo of posterior valve slightly prominent, central.

Interior rose tinted; anterior valve with 8–10, median valves 1, posterior valve 8–9 slits. Sutural plates broad, rounded; sinus deep, angular.

Girdle leathery, nude.

The gill rows extend forward three-quarters the length of the foot, each containing 20–25 branchiæ.

Length 40, breadth 24 mill.

Length 27, breadth 16 mill.

North Atlantic: Massachusetts Bay to Greenland; Holland to Ireland and northward. North Pacific: Aleutian Islands and Japan.

Chiton marmoreus FABR., Faun. Grönl. p. 420, 1780.—FORBES & HANLEY, Hist. Brit. Moll. ii, p. 414, t. 58, f. 2; t. 59, f. 4.—JEFFREYS, Brit. Conch. iii, p. 227; v, p. 199, t. 56, f. 7.—*Chiton, (Tonicia) marmoreus Fabr.* Smith, Ann. and Mag. N. H. (4) xx, p. 139 (Franklyn Pierce Bay, Greenland).—*Tonicella marmorea Fabr.* CPR., Bull. Essex Inst. v, p. 154, 1873; Ann. Mag. N. Hist. (4) xiii, p. 121.—DALL, *l. c.*, vi, p. 124 (anat.); Proc. U. S. Nat. Mus. 1878, p. 324.—*Chiton ruber* SPENGLER, Skrift. Nat. Selsk. iv, p. 92, not of Linné.—*Chiton lævigatus* FLEMING, Edinb. Encyc. p. 113, t. vii; Brit. Anim. p. 290.—REEVE, Conch. Icon. t. 27, f. 179.—*? Chiton punctatus* STRÖM. (teste JEFFR.) Acta Nidr. iii, p. 433, t. 6, f. 14.—*Chiton latus* LOWE, Zool. Journ. ii, p. 103, t. 5, f. 6, 7.—SOWB., Conchol. Illustr. f. 113.—*Chiton fulminatus* COUTH., Bost. Journ. Nat. Hist. ii, p. 80, t. 3, f. 19.—GOULD, Invert. Mass. i, p. 148, f. 3.—*Chiton pictus* BEAN, in Thorpe's Brit. Mar. Conch. p. 264.—*Chiton flemingius* LEACH, Moll. Gt. Brit. p. 230.—*Boreochiton marmoreus Fabr.* SARS, Moll. Reg. Arct. Norv. p. 116, t. 8, f. 3.

This species has very much the color pattern of *C. ruber*, but may readily be distinguished by its nude, leathery girdle. Sars was evidently led by this superficial resemblance to create his genus

Boreochiton for the two forms. The Greenland and East American specimens are more elevated and generally larger than the British form, which might retain the varietal name *latus* Lowe.

Middendorff found the number of slits variable in his specimens from the White Sea and the Arctic coast of Russian Lapland, the anterior valve having 5 to 7, posterior valve 6 to 9 slits.

T. SUBMARMOREA Middendorff. Pl. 10, figs. 16–24.

Shell oval, rather depressed, rather smooth and shining, the entire surface seen under a lens to be very minutely, regularly and closely *granulose*. Lateral areas scarcely distinct, slightly swollen. Color rosy or yellowish-white, closely painted with spots and flames of red. Interior rose colored; terminal valves each with five slits.

Girdle smooth, shining, yellow or brown.

Branchiæ median, consisting of about 24 plumes.

Length 38, breadth 24, alt. 12–13 mill.

Japan, Okhotsk Sea; Aleutian Is. to Sitka and Fuca Strait.

C. submarmoreus MIDD., Bull. Acad. Sci. St. Pétersb. iv, 1846; Mal. Ross. i, p. 98; Sib. Reise. p. 178, t. 14, f. 7–10; t. 15, f. 7, 8. —*Tonicella submarmorea* Midd., DALL, Proc. U. S. Nat. Mus. 1878, p. 296, t. I, f. 7; p. 327; *l. c.* 1886, p. 210.—*Chiton insignis* REEVE, Conch. Icon. t. 22, f. 148, 1847.

This species is readily distinguished from *T. lineata* by its microscopic granulation; from *T. marmorea* by its more depressed shell, different color-pattern, etc.

T. LINEATA Wood. Pl. 11, figs. 25–28.

Shell oblong, rather low, roundly arched or subcarinated. Surface *smooth*, shining, ground color light reddish. End valves concentrically marked with black-brown lines bordered above with white, intermediate valves having similarly colored longitudinal lines, sloping obliquely backward, the ridge or jugum of each valve having a light triangle with a narrower dark one in the middle on some valves. Occasionally some valves are wholly dark brown, unmarked.

Lateral areas scarcely raised; umbo of posterior valve in front of the middle.

Interior white, more or less tinged with rose color. Sutural plates broad, rounded; sinus deep and angular. Anterior valve with 8–10, median 1, posterior valve 8–10 slits. Teeth short, espe-

cially in the posterior valve, and blunt, in adults decidedly crenulated at the tips and obsoletely fissured outside. Eaves small.

Girdle leathery, apparently smooth and nude, brown in dried specimens.

Gills extending forward two-thirds the length of the foot, composed of 27 branchiæ each.

Length 37, breadth 20 mill.

Length 30, breadth 15 mill.; divergence 120°.

From Bering Strait southwestward to the Okhotsk Sea and Japan, southeastward to the Bay of Monterey, California. Aleutian Is.

Chiton lineatus Wood, General Conchology p. 15, t. 2, f. 4, 5, 1815—Midd., Mal. Ross. i, p. 109, t. 12, f. 8, 9.—Sowb., Conch. Ill. f. 77.—Reeve, Conch. Icon. t. 7, f. 33.—*Tonicia lineata* Wood, H. & A. Ad., Genera Rec. Moll. i, p. 474.—*Tonicella lineata* Cpr. *MS.*, p. 38.—Dall, Proc. U. S. Nat. Mus. 1878, p. 326.

In many old specimens of this species the teeth are distinctly, though obsoletely crenulated and striated outside, presenting an approach to *Tonicia*. The slit in the median valves frequently has its edges thickened, and there is a distinct notch on each side of it.

This is one of the handsomest north Pacific Chitons. It is readily distinguished from *T. marmorea* and *T. submarmorea* by the absence of microscopic granulation of the surface, as well as by the pattern of coloring. Dall writes:

The painting of this very characteristic species is very variable, even on different valves of the same individual. Nothing can appear more distinct than the coloration of typical specimens of some varieties, but in a large series the differences do not hold equally good. The number of slits is also somewhat variable, occasional abnormal or injured specimens having only six or seven slits in the tail valve. But fine and normal specimens of both varieties show no more than individual variations.

Middendorff, while pointing out the distinctions between the following species and *T. marmorea*, appears to have overlooked the connection between the former and *T. lineata* and his description does not always agree with his figures.

From *Tonicia lineolata* Sowerby, from South America, besides the internal generic characters, the exterior differs by the absence of punctures and raised granules at the sides.

T. SACCHARINA Dall. *Unfigured.*

Shell small, oblong, the entire surface painted with lustrous red and whitish. Umbo subcentral, inconspicuous. Lateral areas indistinctly raised; dorsal area blood colored, reticulated in quincunx. Anterior valve having 10–11, posterior 8–10, median 1 slit. Teeth small, spongy; sinus small; eaves spongy, moderate. Girdle leathery. Gills median. Length 6½, breadth 4 mill.

Aleutian and Shumagin Is.; Kyska, Unalashka, and Koniushi, 3–13 fms., on stones; *St. Paul, Pribiloff Is.*, 15 fms.

Tonicella saccharina DALL, Proc. U. S. Nat. Mus. 1878, pp. 2, 327.

This interesting little species has the luster of rock-candy, through which the microscopic reticulation is barely perceptible. It is marked in all the specimens obtained, by the red wine colored dorsal areas contrasted with a waxy white color of the lateral areas, rendering its recognition easy. The girdle is dark, leathery, narrow, slightly pubescent, and furnished at its extreme margin with a fringe of fine spiny hairs or spicules, as in *T. marmorea.*

T. SITKENSIS Middendorff. Pl. 11, figs. 29, 30, 31.

Shell depressed, smooth, the lateral areas indistinct, under a lens seen to be sparsely granulose; reddish. Anterior valve having 8, posterior 10, central 1 slit. Gills posterior.

Length 10, width 6 mill.; divergence 130°.

Sitka.

C. sitkensis MIDD., Bull. Acad. Sci. St. Pétersb. vi, p. 121, 1846; Mal. Ross. i, p. 112, t. 13, f. 1, 2.—Not *C. sitkensis* Reeve, 1847.

Described from a single specimen, and not found by later collectors. Middendorff's figures and description do not agree upon several points. The anterior teeth are figured as grooved outside, a character also seen in *T. lineata.*

Subgenus CYANOPLAX Pilsbry, 1892.

Valves resembling those of Ischnochiton, but having the teeth stout, obtuse, crenulated or bi- or trilobed at their tips; and the eaves spongy. Girdle leathery, minutely papillose. Gills extending to the anterior end of the foot.

Differs from *Chætopleura* in the spongy eaves and papillose, *not hairy* girdle; from *Tonicella* in the long gills, different girdle, stumpy, bilobed anterior teeth, etc. It might be considered a

Trachydermon were it not for the peculiar blunt teeth, ambient gills and almost scaleless girdle.

The girdle seems to be dusted with a few small, smooth white scales in places.

On account of the spongy eaves and hairless girdle, I include this subgenus in *Tonicella* rather than in *Chætopleura;* but its close affinities with both of these groups renders the question of its position peculiarly difficult.

T. HARTWEGII Carpenter. Pl. 14, figs. 81, 82, 83, 84, 85.

Shell oval, rather low, the dorsal ridge obtusely rounded; dull olive green, generally having a pair of lighter stripes on the ridge of each valve with a black blotch outside of the light dashes. Girdle (fig. 82) rather narrow, dense, microscopically closely granulated.

The tail valve is convex as a whole, but the subcentral umbo is not conspicuous. The entire surface is *very closely microscopically granulated, and bears larger wart-like granules irregularly scattered over the minute sculpture,* these warts being much more numerous upon the lateral areas (which are otherwise rather ill-defined) and the terminal valves.

The interior is of an *intense blue-green color.* Sutural plates rounded, leaving a wide, angular sinus. Insertion plates shorter than the eaves, blunt, the anterior valve having the teeth bi- or tri-lobed, the posterior valve having them crenulated. Slits of anterior valve 10–11; median valves 1; posterior valves 9–12. *Eaves spongy.*

Gills extending forward to the front end of the foot.

Length 30, breadth 17 mill.

Length 27, breadth 18 mill.

Vancouver Island to Magdalena Bay, Lower California.

Chiton hartwegii CPR. P. Z. S. 1855, p. 231; *Trachydermon hartwegii* CPR. B. A. Rep. 1863, p. 649.—*Chætopleura hartwegii* CPR. *MS.* p. 45.—DALL, Proc. U. S. Nat. Mus. 1878, p. 329.

The prominent differential characters of this species are its system of sculpture, vivid blue-green interior, slightly spongy eaves, stumpy, bilobed teeth of the front valve, etc.

Var. NUTTALLII Cpr.

Umbo flatter; valves broad, non-swelling, squared at the sides, and not beaked or waved. Posterior valve having 11, central 1, anterior 8 slits.

Habitat same as hartwegii.

Chiton nuttallii Cpr. P. Z. S. 1855, p. 231; *Trachydermon n.*, Cpr. Suppl. Rep. B. Asso. 1863, p. 649; *Chætopleura n.*, Cpr. *MS.*, in Dall, Proc. U. S. Nat. Mus. 1878, p. 330.

I am unable to separate this form from *hartwegii*, as transition specimens are numerous.

T. BIPUNCTATA Sowerby. Pl. 14, fig. 90.

Shell ovate, smooth; green, variegated with black and white; margin concolored, generally having a white spot on each side between the first and second valves, marginal ligament smooth. Length 12½, breadth 6¼ mill. (*Sowb.*)

Inner Lobos Island, Peru, under stones at low water.

C. bipunctatus Sowb. P. Z. S. 1832, p. 104; Conch. Illustr. f. 27.

This species varies much in coloring, some specimens being nearly black, others light green, and some much and prettily varied. In almost all a white mark may be observed on the margin just behind the anterior valve. (*Sowb.*)

Carpenter's notes on the types are as follows: Posterior valve having 9, central 1, anterior valve 9 slits; teeth smooth, stumpy; eaves very short, spongy. Girdle smooth with extremely short, scattered hairs, and two white spots at the sutures of anterior valve. Valves beaked, but they seem to have no pattern of sculpture, only a very close quincunx (arrangement of granules). Looks like a *Trachydermon* without scales. The mucro is in front of the middle, the slope behind it concave. Color greenish, generally with a white blotch behind.

Length 12, breadth 7 mill.

Congeneric with and very like a small *nuttallii*.

Genus IX. SCHIZOPLAX Dall, 1878.

Schizoplax Dall, Proc. U. S. Nat. Mus. p. 2, Jan., 1878; *l. c.* p. 328.—Cpr. *MS.* Type *Chiton brandtii* Midd.

Shell and girdle as in *Tonicella*, except that the median valves have a central jugal slit filled with cartilage, narrower in front;

tegmentum very spongy; gills extending three-fourths the length of the foot.

This form, whilst allied to *Tonicella*, differs from all other known Chitons in the curious slit along the jugum of each of the median valves. This slit is wedge-shaped, narrowing to a point in front, where it is lost in the spongy jugal sinus. The slit is filled with a cartilaginous substance resembling the ligament of a bivalve. Outside there is a corresponding furrow not extending to the terminal valves.

The tegmentum, or external layer of shell substance, is remarkably porous where exposed at jugal sinus and eaves.

S. BRANDTII Middendorff. Pl. 11, figs. 32–37.

Shell oval, rather elevated, the jugum rounded; olive-brown, streaked, maculated or clouded with blue, sometimes chestnut. Umbo central, irregularly planate. Lateral areas scarcely defined. Entire surface smooth, seen under a lens to be finely granulated in quincunx. Girdle narrow, olive-ashen, maculated, closely beset with minute spines, but appearing almost smooth to the naked eye. The median valves have a sharply cut longitudinal median sulcus. The jugal sinus is moderate, deep, scarcely laminate, conspicuously spongy. Eaves small, very spongy. Anterior valve with 11, posterior 11 and median valves with 1 slit. Gills about 22, subambient.

Length 16, width 5 mill.; divergence 140°.

Shantar Bay, Okhotsk Sea; Aleutian Is. eastward to Sitka Harbor, low water to 12 fms., on stones and shells.

C. brandtii MIDD., Bull. Acad. Sci. St. Pétersb., vi, p. 117, 1846; Mal. Ross. i, p. 128: Siber. Reis. p. 174, t. 15, f. 1–6.—*Schizoplax brandti* CPR. *MS.*—DALL, Proc. U. S. Nat. Mus. 1878, pp. 2, 328.

This very remarkable species is very prettily marbled with olive, chestnut and blue; the girdle generally dark olive, dashed with ashy spots and in fine specimens having a pubescent appearance. The slit is occupied by a cartilaginous substance of a dark brown color, most visible from within. It is quite possible that it may reach as far south as Puget Sound.

The soft parts are yellowish-white. The gill rows extend three-fourths of the length of the foot forward from their posterior termination, and each contains about twenty-two branchiæ. Mantle-edge thick, plain; veil small, plain. Muzzle small, plain, with two large squarish lappets at the posterior corners. The supposed oviducts

open on each side through a small rounded papilla in the vicinity of the third or fourth branchia, counting forward, and between the line of the gill row and the side of the foot. (*Dall.*)

Genus X. CALLOCHITON Gray, 1847.

Callochiton Gray, P. Z. S. 1847, pp. 126, 168; type *Ch. lævis.*—Shuttlew Bern. Mittheil., Juni, 1853, p. 65.—*Callochiton* Gray, Guide Syst. Dist. Moll. B. M. p. 181, 1856.—*Callochiton* Carpenter *MS.* 1871, and of Dall, Proc. U. S. Nat. Mus. 1882, p. 286, not *Callochiton* of Carpenter's earlier writings (P. Z. S. 1865, p. 276, etc.), = *Callistochiton.*

Valves exposed; insertion plates rising out of porous or spongy eaves and cut into numerous teeth; sutural plates connected or continuous across the shallow jugal sinus.

Two subgenera are recognized by Carpenter:

Subgenus Callochiton (restricted).

Girdle covered with a smooth, compact layer of very small diamond-shaped scales.

Subgenus Stereochiton Cpr.

Girdle leathery, more or less downy, frequently naked when the delicate scales are rubbed off.

Subgenus Callochiton *s. str.*

The essential characters of the restricted genus *Callochiton* are correctly stated by Carpenter as follows: (1) The insertion plates are broken up into very numerous teeth rising out of spongy eaves; (2) that these have a tendency to become propped outside; (3) that the sinus is a mere wave in the otherwise united branches of the sutural laminæ; (4) that the mantle is reticulated with what look like diamond-shaped scales, which are only the points of long, flattened, closely appressed corneous bodies, not found on any other Chiton. For Gray's second group, in which the peculiar covering is not seen, a subgenus should be created, unless indeed the species may rank under Trachyradsia. For two species with a mantle intermediate between Chætopleura and Tonicella I have established a subgenus Stereochiton. Of the whole series there are very few species known. All of them are rare and display very little sculpture on the valves.

C. LÆVIS Montagu. Pl. 9 figs. 95–99.

Shell oblong, rather elevated and rather acutely carinated, the sides straight or convex. Color very variable, but mainly yellowish-olive, spotted and marbled more or less with dark red or reddish, but green often predominating. Girdle olive with creamy spots, and often red patches.

The valves are slightly beaked and apparently smooth, but under a lens a fine but half-effaced granulation is seen. The lateral areas are distinctly raised. The umbo is low and in front of the center.

Interior pink-tinted. Anterior insertion plate having 14 to 17 slits, median valves with about 3 slits, posterior valve with 14–16 slits. The teeth rise from very spongy eaves, and are more or less thickened at the sides or "propped." Sutural plates continuous, the jugal sinus indicated by a shallow depression.

Girdle firm, smooth and wide, composed of excessively fine diamond-shaped scales.

Length 21, breadth 11 mill., sometimes larger.

British Seas; Mediterranean.

Chiton lævis Montagu, Test. Brit. p. 2.—Reeve, Conch. Icon. f. 125.—Forbes & Hanley, Hist. Brit. Moll. p. 411, t. 58, f. 3.—Jeffreys, Brit. Conch, iii, 226, t. 56, f. 6.—*Chiton marginatus* of some authors.—*C. achatinus* Brown, Illustr. Conch. Gt. Brit. p. 65, t. 21, f. 4, 12, 13, 15.—*C. septemvalvis* Mont., Test. Brit. p. 3 and *C. discors* Maton & Rackett, Trans. Linn. Soc. viii, p. 20.—*Chiton cranchianus* Leach, Moll. G. B. p. 230.—*Lepidopleurus punctulatus* Leach, *l. c.* p. 228.—*Chiton doriæ* Capellini, Journ. de Conchyl. (2), iii, p. 325, t. 12, f. 2, a″, b″, c″, 1859.

This is a rather high and sharply keeled species although depressed specimens occur. It may be known from other European Chitons by the comparative smoothness of both valves and girdle, the latter wide and covered with very fine diamond-shaped scales; by the propped teeth and spongy eaves, the number of slits in the median valves, etc.

The Mediterranean form has been called *C. doriæ*, but I am unable to see that it has distinctive characters.

C. PLATESSA Gould. Pl. 10, figs. 1–5.

Shell smooth, entire surface delicately shagreened, terminal valves and lateral areas only with indistinct concentric lines of growth;

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lateral areas not prominent, with no radial markings; umbones small, pointed.

Girdle.—With delicate flat elongated scales.

Gills.—Extend along whole length of foot, about thirty in number on each side.

Color.—Central areas yellowish, obscurely mottled with orange; on some valves there are a central and a lateral pair of pale lines. Lateral areas and terminal valves of a uniform dull orange color, and uniformly spotted with minute black dots, which are absent from the central areas, the posterior border of the valves is ornamented with alternate lighter and darker spots. Ligament brownish, with a few irregular small white flecks and five large white spots, four very large spots extending from the points of junction of the first and second and seventh and eighth valves respectively to the edge of the girdle; the fifth spot being in the median line posteriorly. (*Haddon.*)

Interior. Posterior valve with 14, anterior 16 and median valves with 3 slits. Teeth solid, separated, propped outside, bifid or 3-shaped. Eaves very spongy, simple, short. Sinus small, wide; sutural plates united; girdle normal. (*Cpr.*)

Sydney; Port Jackson; Botany Bay; Australia; (and New Zealand?).

C. platessa Gld., Proc. Bost. Soc. N. H. ii, 1846, p. 143; U. S. Expl. Exped. p. 320; atlas, f. 434, 434a, left hand, under *Ch. fruticosus.*—*Lepidopleura platessa* Gld., Otia Conch. p. 242.—*Callochiton platessa Gld.*, Cpr., *mss.*—Haddon, Challenger Rep. p. 15.—*Chiton crocinus* Rve., Conch. Icon. t. 22, f. 146, 1847.—*Chiton versicolor* A. Ad., P. Z. S. 1852, p. 92, t. 16, f. 5.—*Leptochiton versicolor*, Angas, P. Z. S. 1867, p. 223.

There is an error in the lettering of Gould's plate, the figures being numbered 434 instead of 431. There is considerable variation in coloring. *C. versicolor*, which Carpenter considered a synonym, is represented in pl. 10, fig. 6. *C. crocinus* (pl. 10, fig. 7) is a larger form, length 35 mill., said to be from New Zealand.

C. princeps Carpenter, n. sp.

Shell large, very flat, oval; jugum angulate; red, streaked with paler and deeper. Posterior valve large, very flat, the median umbo inconspicuous. Lateral areas hardly defined; central valves

rounded at the margins, sometimes (abnormally?) pectinated. Entire surface conspicuously but minutely granulated.

Interior: Posterior valve having 17, anterior 18, median valves 3 slits. Teeth elegantly radiately propped, curved outward, two or three lobed, sometimes striated. Eaves short, reddish, spongy. Inside light flesh colored. Sutural plates joined, broadly but slightly sinuated in the middle. Girdle normal. (*Cpr.*) Length 32½, breadth 20 mill.; divergence 135°.

Habitat unknown. (Mus. Cum. No. 95.)

The complicated external structure of the insertion plates is more beautiful in this than in any other known species, resembling the fret-work of a Gothic pinnacle. It is specially displayed where the eaves have been broken off through accident, and the grooving is displayed under the colored part of the valves, which are there pectinated at the edges. It is unfortunate that the locality of this typical species is unknown. (*Cpr.*)

C. ILLUMINATUS Reeve. Pl. 9, figs. 92, 93, 94.

Shell oval, red, rather elevated, the jugum acute; umbo a little in front of the middle, slightly elevated. Entire surface very minutely wrinkle-striate and granulose under a lens, the central areas longitudinally, the rest radially. Central areas with slender elevated separated threads, parallel to the jugum, 6 to 14 on each side. Lateral areas rather elevated.

Interior roseate. Anterior valve with 15–16, posterior with 11–14 slits, median valves with 1 slit. Teeth acute, quite distant, scarcely propped. Eaves spongy, sinus small, the sutural plates connected across it. Girdle normal, the scales rather large, solid; sometimes spotted with paler at the sutures. (*Cpr.*)

Length 16, breadth 10 mill.; divergence 120°.

Straits of Magellan.

Chiton illuminatus REEVE, Conch. Icon. t. 22, f. 147, 1847.—*C.* (*Callochiton*) *illuminatus Rve.*, SMITH, P. Z. S. 1881, p. 35.—*Lepidopleurus illuminatus* ROCHEBRUNE, Miss. Cap Horn, p. 141.

There are about 16 gill plumes on each side, reaching three-fifths of the distance forward, according to Carpenter. In having but one slit in the median insertion plates and in the want of props on the teeth this species is abnormal; in other respects it agrees with *Callochiton*.

Subgenus STEREOCHITON Carpenter.

Stereochiton CARPENTER *MS.*, 1871.—DALL, Proc. U. S. Nat. Mus. 1882, p. 286 (type *C. castaneus* Wood).

Valves like *Callochiton*, but the girdle leathery and downy, the scales very delicate and deciduous. In this group the teeth are numerous, the median valves having 5 or more; but on account of their narrowness they do not always have the lateral buttresses or props outside, so characteristic of the teeth of the true Callochitons. The eaves are very narrow, but distinctly porous or spongy, as in Callochiton, and the bottoms of the slits are also coarsely spongy. The sutural plates are continuous from side to side, the median sinus being a mere wave, also a characteristic of *Callochiton*. It is therefore obvious that the characters of the girdle alone separate *Stereochiton* from *Callochiton*. In *C. castaneus* the girdle of moderate sized specimens is always, so far as I know, denuded of most of the covering of downy scales, but under a strong lens the close, fine markings where they were inserted in the girdle may be seen, as well as occasional scattered scales.

Stereochiton externally resembles *Tonicella*, but it may be at once distinguished from that group by its numerous side slits.

C. CASTANEUS Wood. Pl. 9, figs. 86–91.

Shell oval, depressed, dark chestnut brown or variegated with lighter brown. Jugum obtusely keeled; lateral areas *rather distinctly defined*, slightly raised. Entire surface very minutely, densely granulated, when seen under a lens; the granules low, not arranged in *distinct* lines, but an obscure oblique radiation is more or less visible. Growth striæ light. Umbo of the posterior valve somewhat in front of the middle, somewhat elevated.

Interior *rose colored;* Anterior valve with 20, posterior with 18, median valves with 5 deep slits. Teeth rather high and *narrow, blunt*, not propped, those of the terminal valves frequently bilobed or trilobed inside, and obtusely crenulated at their apices. *Interstices spongy.* Eaves very narrow, short, spongy. Sutural plates connected, the jugal sinus shallow. Girdle leathery, bearing (when not rubbed off) delicate elongated scales.

Length 42, breadth 28 mill.

Cape of Good Hope.

Chiton castaneus WOOD, General Conchology, p. 13, t. 2, f. 2, 3; t. 3, f. 2, 3, 1815.—SOWERBY, Conchol. Illustr. f. 114, 115.—REEVE,

Conch. Icon., t. 5, f. 25.—Not *C. castaneus* Quoy nor *C. castaneus* Conth.—*C. cerasinus Chemn.*, Reeve, Conch. Icon. f. 63.

This species is variable in coloring, being either uniform chestnut brown or having spots and patches of brown on a lighter ground. The interior is always roseate. The numerous narrow teeth, short spongy eaves, spongy slits, etc., readily separate it from other forms.

C. lobatus Carpenter, n. sp. Pl. 8, figs. 83–85.

Shell large, flattened, with *acute jugum;* intense *olive colored;* umbo median, the posterior slope concave. Valves scarcely beaked, rounded at the margins. *Lateral areas not well defined.* Entire surface minutely granulated in quincunx.

Interior: Posterior valve with 20, median valves 5 to 7 (usually 6, the posterior minute), anterior valve 24 slits. Teeth small, deeply separated, *and outside very strongly propped*, as if bilobed; *interstices deeply spongy.* Eaves small, spongy, grooved inside; sinus subobsolete; sutural plates connected. Girdle leathery, smooth, under a lens seen to bear short, minute, sparsely placed hairlets. Length 41, breadth 27½ mill.; divergence 130°.

Tasmania. (Mus. Cum. No 19.)

This fine and curious species has the general aspect of Mopalia vespertina (from which it is known at once by the lophyroid mucro); the insertion plates, props, spongy eaves and minute sinus of Callochiton; and a mantle resembling an aberrant Tonicia.

Genus XI. ISCHNOCHITON Gray, 1847.

=*Ischnochiton* + *Trachydermon* + *Maugerella* Cpr.

Valves external, having sharp, slit, insertion plates, the teeth not buttressed. Eaves solid (rarely somewhat porous in s. g. *Trachydermon);* girdle covered with imbricating scales, either flat or convex, smooth or striated. Gills typically extending the entire length of the foot, but in some species they are short in front or at both ends.

Ischnochiton is the typical or central point in development of the sharp-toothed division of Chitons, around which the other genera naturally group themselves.

The great diversity in the girdle covering permits us to use that character for the foundation of a number of subgeneric and sectional divisions, as follows:

Synopsis of Subgenera and Sections.

Subgenus I. STENOCHITON Ad. and Ang.

Very much elongated, valves longer than wide, roundly arched, the median valves having several slits; umbo subcentral; girdle covered with minute, smooth imbricating scales.

Subgenus II. STENOPLAX Cpr.

Elongated, narrow, the posterior valve large, depressed, with subcentral or posterior umbo. Girdle covered with small crowded striated scales.

Section *Stenoplax* s. s. Median valves 1 slit.

Section *Stenoradsia* Cpr. Median valves with several slits.

Subgenus III. ISCHNOPLAX Cpr.

Elongated, narrow; posterior valve elevated, the umbo posterior; girdle covered with very minute scales, having conspicuously larger, striated scales mingled among them.

Subgenus IV. HETEROZONA Cpr.

Shell like normal Ischnochiton. Girdle bearing small scales with large striated scales intermingled.

Subgenus V. TRACHYDERMON Cpr.

Oval; valves having the sharp teeth of normal Ischnochiton; eaves narrow, rarely spongy. Girdle having *very small* smooth scales.

Section *Trachydermon* s. s. Median valves having one side slit.

Section *Trachyradsia* Cpr. Median valves having more than one side slit.

Subgenus VI. ISCHNOCHITON (Gray) Cpr.

Oval or oblong; valves having sharp smooth teeth and solid eaves. Girdle covered with short flat, generally striated imbricating scales of moderate size.

Section *Ischnochiton* s. s. Central valves having one slit.

Section *Radsiella* Pils. Central valves having two or several slits.

Subgenus VII. Ischnoradsia Shuttlew.

Shell oval, as in Ischnochiton; girdle covered with solid, convex, smooth scales, like those of *Chiton s. s.*

Section *Ischyoradsia* s. s. Median valves having several side slits. Type *I. australis* Sowb.

Section *Lepidozona* Pils. Median valves having one side slit. Type *I. mertensii* Midd.

Subgenus I. Stenochiton Adams and Angas, 1864.

Stenochiton Ad. and Ang., P. Z. S. 1864, p. 193.

Shell very much elongated, roundly arched; valves Ischnoid, the central valves having several slits; girdle having minute smooth imbricating scales.

This section was discarded by Carpenter, who referred its only species to his own later group *Stenoradsia* with doubt; *Stenochiton*, however, seems to have as much individuality as most of the divisions of *Ischnochiton*, and may be allowed to stand as a subgenus.

I. juloides Adams and Angas. Pl. 16, figs. 6, 7, 8.

Shell much elongated, narrow, narrower in front; rufous brown, minutely spotted with white. Valves narrow, longer than wide, very convex, not carinated; lateral margins scarcely rounded, polished. Lateral areas elevated and at the margins concentrically sulcate. Girdle narrow, pale-brown, spotted with black-brown, covered with very minute, polished, imbricating scales. (Ad. and Ang.) Length 25, breadth 6 mill.

Holdfast Bay, South Australia.

Stenochiton juloides Ad. and Ang., P. Z. S. 1864, p. 193; *l. c.* 1865, p. 58, t. 11, f. 15.—Angas, P. Z. S. 1865, p. 188.—"*? Stenoradsia*" *juloides* Ad. and Ang., Cpr. *MS.*

This species, from its narrow, convex form and polished surface has much the general appearance of a Myriapod. (*Ad. and Ang.*)

This species is the type of the genus *Stenochiton* Adams and Angas, which is thus characterized by them: "Shell elongated, narrow, convex; valves longer than wide, not carinated; apex of the posterior valve subcentral; plates of insertion small, multifissate in the end valves, the intermediate valves having 5 fissures on each side; girdle covered with very minute, polished, imbricating scales."

Carpenter gives the following notes on the type specimen: Length 22½, breadth 4½ mill.; shell very narrow, elongate, elevated, cylindrical, the jugum rounded; red-brown, narrowly streaked with paler. Posterior valve elongated, mucro median, scarcely conspicuous, the slope behind it straight. Anterior valve forming more than a semicircle, its posterior margin (suture) emarginate. Entire surface delicately granulated in quincunx; jugal area scarcely defined; lateral areas conspicuously elevated. Girdle inconspicuous, covered with minute imbricating scales. Scales almost all destroyed, but looking like those of *I. sanguineus*, etc. Sinus large, very deep, flat, wide; sutural plates much elongated, narrow. Central valves regularly 3-slit; posterior valves about 16, anterior valves about 13 slits. The slits are irregular, sometimes bifurcating but typically rather distant. Teeth very acute, moderately long. Eaves moderate.

Subgenus II. Stenoplax Carpenter, 1878.

= *Stenoplax* Cpr. + *Stenoradsia* Cpr. + *Maugerella* Cpr.

Elongated, narrow Ischnoids, having the girdle covered with minute, crowded, imbricating striated scales. Median valves having the lateral areas much raised; posterior valve large, depressed, the mucro subcentral or slightly posterior.

The subgenus *Stenoplax* (+ Stenoradsia and Maugerella) has a very characteristic peculiarity. The sides and front end of the foot are so much dilated that the head of the animal is nearly or entirely concealed from below, the thin, produced, anterior end of the foot extending quite over it. The gill row is shortened at both ends, reaching nearly to the head, but shortened at the tail about one-fourth the entire length of the foot. The branchiæ are largest at the middle.

Stenoplax divides naturally into two sections: (1) Section *Stenoplax* (restricted), in which the median valves have a single slit on each side, and (2) Section *Stenoradsia*, the species of which have two or several side slits in the median valves.

Section *Stenoplax* Cpr. (restricted).

Stenoplax Cpr., *MS.* and table of Regular Chitons, 1873.—Dall, Proc. U. S. Nat. Mus. 1878, p. 330, type *I. limaciformis* Sby.

This section is closely allied to *Stenoradsia*, the latter differing only in having several slits in the plates of the intermediate valves.

I. LIMACIFORMIS Sowerby. Pl. 16, figs. 9–16.

Shell elongated and narrow, elevated, well arched; buff, gray or greenish, indistinctly marbled with darker, and occasionally blotched with red; longitudinally costulate, not granose; girdle scales very minute.

The sculpture upon the central areas consists of fine, close, smooth longitudinal riblets; these continue upon the lateral areas, becoming broader and flat there, and being decidedly waved or irregular on the slope between central and lateral areas. The end valves are sculptured with close, flattened concentric ridges, which are more or less wavy or irregular. The lateral areas are well raised, and are separated by a considerable space at the jugum. The mucro is subcentral and low.

Interior stained with bright pink and blue-green; sutural plates well developed; sinus flat, angular, wide; anterior valves with 11, central valves 1, posterior valves 9 slits. Teeth sharp, smooth; eaves grayish, solid.

Girdle covered with extremely minute subequal scales.

Length 35, breadth 12 mill.

Length 25, breadth 10 mill.

Florida Keys; St. Thomas, St. Vincent and West Indies generally; Central America and Peru; under stones at low water.

Chiton limaciformis SOWERBY, P. Z. S. 1832, p. 26; Conchol. Illustr. f. 38.—REEVE, Conch. Icon. t. 8, f. 42.—*Ischnochiton limaciformis* SHUTTLEW, Bern. Mittheil. 1853, p. 190.—*Ischnochiton (Stenoplax) limaciformis* Sowb., CPR. *MS.*, and DALL, Blake Gastrop. p. 415.—*Ischnochiton multicostatus* Ad., DALL, Proc. U. S. Nat. Mus. vi, p. 337, 1883, not of C. B. Adams.—*Chiton productus* REEVE, Conch. Icon. t. 17, f. 97, 1847.—*Chiton sanguineus* REEVE, *l. c.* f. 98.—*? Lepidopleurus sanguineus* CPR., Maz. Catal. p. 194.

The West Indian specimens collected by Robert Swift at St. Thomas, and the Peruvian specimens which I have examined are absolutely identical in character except that the former are finely mottled with pink, and one specimen is heavily blotched with crimson on the second and tail valves (fig. 9). Another tray from the Swift collection contains pale buff examples with faint darker markings. Carpenter has reported the same species, or one very closely allied, from Mazatlan and from Japan. The last certainly requires confirmation.

The characteristic mark of this species is the sculpture of the lateral areas and end valves, which are non-granulated but have slightly serrated concentric flat riblets. The girdle scales are flat, solid, not striated or very obsoletely so, and far more minute than in *I. alatus*.

I. FLORIDANUS Pilsbry, n. sp. Pl. 17, figs. 19–22.

Shell elongated, narrow, elevated, the valves roundly arched, not carinated. Color whitish or delicate green, variously marked and mottled with olive, blackish-olive or gray.

The lateral areas are raised, longitudinally costulate, the riblets cut into granules by radiating impressed or incised lines developed over the whole area or over the forward half of it. End valves similarly cut into granules by radiating and concentric lines. Central areas covered with longitudinal riblets which are finer and closer upon the jugum, usually showing a tendency to be a little irregular on either side of it, and are granulous toward the outer angles of the areas. Posterior valve large, rather depressed, the mucro slightly posterior.

Interior pink, blue and white, in various proportions, rarely all roseate or all white. Sutural plates strongly developed, rounded; sinus wide, deep, square. Anterior valve having 9, central valves 1, posterior 9 slits; teeth sharp, smooth or very obsoletely lobed. Eaves narrow, solid.

Girdle delicately marbled with bluish and gray, densely clothed with rounded, solid, delicately striated scales.

Length 41, breadth 15 mill.

Length 35, breadth 11½ mill.

Key West, Florida. (Hemphill.)

This species is allied to *I. limaciformis*, differing in the differently sculptured lateral areas. It is also related to *C. purpurascens* C. B. Ad., but differs in several respects, notably in the flatter posterior valve and longer central valves.

I. PURPURASCENS C. B. Adams. Pl. 17, figs. 23, 24.

Shell elongated, narrow, much elevated, the lateral slopes of the valves nearly straight, dorsal ridge roundly subangular. Generally pale buff, marbled with olive or mottled with black, and having red patches along the dorsal ridge. The lateral areas are raised and longitudinally ribbed, the riblets cut into granules by radiating impressed lines; end valves cut into coarse granules by radiating

and concentric lines. Central areas having the dorsal ridge smooth or only minutely punctured; the longitudinal riblets of the lateral areas extend forward upon the "pleura" or sides of the central areas. Posterior valve elevated, the mucro slightly posterior, elevated.

Interior white or stained; sutural plates short; sinus wide, flat. Anterior valve having 10, central valves 1, posterior valve 10 slits. Teeth sharp, smooth. Eaves narrow.

Girdle rather wide, alternately bluish and buff, densely clothed with minute, solid, striated scales. Length 16, breadth 7 mill.

Jamaica (Adams); *Key West, Florida* (Hemphill; Rush.)

Chiton purpurascens C. B. ADAMS, Proc. Bost. Soc. N. H. ii, p. 9, 1845.—*Ischnochiton purpurascens* Ad., DALL, Bull. U. S. Nat. Mus. No. 37, p. 172.

Adams' description is as follows: Shell much elongated, purplish-ruddy, concentrically striated; margin wide, very minutely scaly, bluish, alternately paler. Length 1·1, breadth ·5 inch.

This species differs from *I. floridanus* in having all of the valves decidedly shorter and broader; the posterior valve much more elevated, the jugum almost smooth. It differs from *I. limaciformis* in having the lateral areas and end valves conspicuously granulose, etc.

In this species the valves are almost as short as in the typical *Ischnochitons*, but the sculpture is quite that of *Stenoplax*. The mucro is more raised than in any other described *Stenoplax*. The species is abundant at Key West.

The color-pattern is excessively variable.

I. FALLAX Carpenter, n. sp. Pl. 16, figs. 17, 18.

Almost exactly like Ischnochiton magdalenensis in form and sculpture, but more roseate; the central areas pitted; lateral areas having close radiating wrinkles interrupted by lines of growth. Interior: Posterior valves having 9, central 1, anterior 10 slits; teeth acute; eaves conspicuous; sinus moderate, scarcely laminate, but the jugal part of the valves produced forward. Girdle having very minute granules.

Length 27½, breadth 12½ mill.; divergence 120°.

Monterey, California.

The color is either entirely reddish-fleshy or clouded and dotted with olive and whitish. The main distinction between this form

and *I. magdalenensis* is that the latter has radsioid valves and coarser girdle scales. Carpenter's description is given above, and the figures represent the type specimen.

The foot is produced forward, and the gill row is short at both ends.

I. ALATUS Sowerby. Pl. 16, figs. 1–5.

Shell much elongated, narrow, elevated, rather thin. On a light fleshy buff or greenish ground it is delicately marbled and mottled with olive or olive-green. The sculpture consists of longitudinal close, narrow ridges, which are finer on the dorsal ridge, and change to an irregular granulation on the lateral areas and terminal valves. The lateral areas are decidedly raised; the jugal area is divided from the pleura by a change in sculpture, which becomes coarser and more or less divaricating, sometimes forming a cellular pattern at the edges of the jugal area and on the slopes of the lateral areas.

Interior rose-pink, rarely almost white; anterior valve having 9, central 1, posterior valve 9 slits. Teeth sharp, eaves moderate, solid. Sutural plates large, rounded; sinus very deep, narrow.

Girdle wide, thin, covered with fine, even, short, striated solid scales.

Length 57, breadth 16 mill.

Length 40, breadth 16 mill.

Islands of Siquijor and Zebu, Philippines, under stones at low water.

Chiton alatus SOWERBY, P. Z. S. 1841, p. 61.—RVE, Conch. Icon. t. 8, f. 45.—*Ischnochiton alatus* GRAY, P. Z. S. 1847, p. 127, and *I. altus* Gray, Guide, p. 182.—*Stenoplax alata* CPR. *MS.*

The solid, deeply striated scales of the girdle are very characteristic, as is also the sculpture. The pattern of color is an indefinite and variable mottling. Figures 3, 4, 5 are drawn from a typical specimen received from Sowerby. Figures 1, 2 are from drawings made for Carpenter, and represent the scales as much more elongated, and the head valve as less emarginate. I am disposed to believe that this last peculiarity is a mistake.

The sole is produced forward as far as the mouth; head fleshy; veil copious, neck lappets long. Gills about one valve's breadth removed from neck and the same at tail. Vent inconspicuous. Foot fleshy, projecting.

Section *Stenoradsia* Carpenter, 1878.

Stenoradsia Cpr. (*MS.*, and table of Reg. Chitons, 1873), Dall, Proc. U. S. Nat. Mus. 1878, p. 330, type *C. magdalenensis* Hinds. —*Maugerella* Cpr. *MS.* and table of Reg. Chitons, type *M. conspicua* Cpr. *MS.*—*Ischnoradsia* (in part), Shuttlew., Bern. Mittheil. 1853, p. 66.

Like *Stenoplax*, but intermediate valves having several side slits. The Radsioid valves alone distinguish this from *Stenoplax*. Its relations with the Australian *Stenochiton juloides* are probably not especially close.

In one species, *I. conspicuus*, the mantle scales have been transformed into short, round, striated bristles, and on account of this modification Carpenter established for it a subgenus under *Chætopleura* which he called *Maugerella*. We are compelled to suppress this group because of the excessively close relationship existing between *I. conspicuus* and the two species of genuine *Stenoradsia, I. acrior* and *I. magdalenensis*.

I. acrior Carpenter, n. sp. Pl. 14, figs. 86–89.

Shell much like *I. magdalenensis*, but broader and flatter, with much sharper sculpture. Olive-green, pink where worn, or sometimes light flesh-colored, with the jugum or central areas often green. Girdle dark ashen or olive.

The anterior valve is notably concave, as in *I. conspicuus*. The lateral areas are much raised, and sculptured with acute radiating riblets, sometimes splitting; central areas having acute longitudinal riblets.

Interior pink, with a blue spot at the jugal sinus. Sutural plates wide, pink; sinus broad, deep, angular. Anterior valves having 13–15, central valves 2–4, posterior valves 10–13 slits. Teeth long, sharp, smooth. Eaves wide, dark-blue.

Girdle wide, tough, covered with very small, solid, short scales.

Length 110, breadth 55 mill.

Length 75, breadth 40 mill.

Cerros (Cedros) Island to Cape St. Lucas, Lower California.

Stenoradsia acrior Cpr. *MS.*—*Chiton magdalenensis* (part) Reeve, Conch. Icon. t. 4, f. 20a, not of Hinds.

This species represents one extreme of variation of the *I. magdalenensis* type, the other extreme being *I. conspicuus*. I have

still to see specimens truly connecting the three forms, although they are doubtless closely allied. The present form differs from *magdalenensis* in having a concave head valve, strong, distinct, acute riblets upon the central areas, and a generally more robust growth.

I. conspicuus also has a concave head valve, but the sides of the central areas show no sculpture except microscopic granulation, and the scales of the girdle are pulled out into true spines or bristles.

There is a light form of *acrior* which is fleshy-white, the girdle gray-white or dark; and some of these have the jugum or the central areas of the normal green-olive color (fig. 89.)

I. MAGDALENENSIS Hinds. Pl. 15, figs. 98, 99, 100.

Shell elongated, rather narrow, generally faintly mottled with delicate olive on a light greenish, blue or pinkish ground. Interior bluish, white or pink. Lateral areas and end valves having radiating riblets, central areas finely pitted.

The lateral areas are distinctly raised, radiately delicately ribbed. *Front slope of the anterior valve straight.* Central areas having a more or less developed system of branching *reticulating wrinkles producing oblong or diamond-shaped pits.* Umbo of posterior valve central, but little projecting.

Interior: Sutural plates well developed, the sinus deep, angular. Anterior valve having 10–13, central valve 2–4, posterior valve 10–12 slits.

Girdle having fine, close, solid imbricating scales.

Length 75, breadth 30 mill.; divergence about 130°.

Length 55, breadth 27 mill.

Monterey, California, south to Magdalena Bay; Catalina and Sta. Barbara Is.

Chiton magdalenensis HINDS, Zool. Voy. 'Sulphur' ii, p. 54, t. 19, f. 1.—REEVE, Conch. Icon. t. 5, f. 20b.—*Stenoradsia magdalenensis* CPR.—*S. "magdalensis"* KEEP, West Coast Shells, p. 107, f. 94, and of collectors generally.

This species differs from *I. conspicuus* in its *pitted* instead of finely granulose central areas and in the mantle-covering of minute, solid *scales,* unlike the short spines of the other form. It differs from *I. acrior* in the much finer sculpture and more delicate coloring.

The foot projects forward, concealing the head from beneath.

I. CONSPICUUS Carpenter, n. sp. Pl. 15, figs. 91–96.

Shell large, elongated, moderately elevated; green (or rarely earthy-brown), but where eroded at the beaks it is pink. Interior pink, with a blue spot at the jugal sinus. Lateral areas much raised, having acute radiating riblets or striæ; *central areas apparently smooth*, but microscopically granulated, sometimes having some faint longitudinal striæ at the jugum. *Front slope of the anterior valve concave; girdle densely beset with short bristles, giving it a velvety aspect.*

The entire surface is very densely microscopically granulated, where not eroded. The lateral areas have fine acute radii and often the back edge of each valve is crenulated by oblique, sharp, little folds. The color is often varied by darker little flames on the central areas. The posterior valve is large and depressed.

The sutural plates are large, the sinus deep and angular. Insertion plates having in anterior valve 9, central valves 2 or 3, posterior valve 10 slits. Teeth sharp and thin in posterior and central valves, but blunt and bi- or trilobed in anterior valve. Eaves wide, solid, light blue-green colored.

Length 82, breadth 36 mill.

Length 89, breadth 41 mill.

Santa Barbara, California, to Magdalena Bay.

Maugerella conspicua CPR. *MS.*—ORCUTT, Proc. U. S. Nat. Mus. 1885, p. 544.

This species may be separated from *I. acrior* by its unsculptured central areas and velvety rather than scaly girdle. It is more closely allied to *I. magdalenensis* and may, indeed, prove to intergrade with that species; but in *magdalenensis* the front valve is scarcely concave in front, the sides of the central areas have a honeycomb sculpture, and the girdle is very finely *scaly*, not *velvety*.

A specimen before me from Magdalena Bay is ferruginous brown, the central areas are more rugose, and the size is smaller, length 45, breadth 20 mill. Another specimen has the central areas sculptured like *I. acrior*, but less strongly; the girdle being bristly, however, as in typical *conspicuus*. San Diego may be regarded as the center of distribution of this species.

Carpenter has given a varietal name to a broad, worn specimen, which he thus describes:

Var. *solidus* (pl. 15, fig. 97). Very solid, wide, ashen; inside whitish, the posterior valve with 10, central valve 2–3, anterior valve 12 slits. Length 72, breadth 40, divergence 130°.

Carpenteria, near Sta. Barbara, California.

This is scarcely more than an individual variation. The figure represents the valves only of the type specimen. The mantle is normal. The sculpture is worn away except at the edge. It has evidently lived in a very exposed situation.

Subgenus III. Ischnoplax Carpenter.

Ischnoplax Cpr. (Table of Reg. Chit. 1873), Dall, Proc. U. S. Nat. Mus. 1878, p. 330, type *C. pectinatus* Sowb.

Body elongated, elevated, the valves having high sutural plates and strongly elevated lateral areas; *mucro posterior*, elevated; girdle clothed with *very minute imbricating scales* and having *larger conspicuous striated scales scattered among them.*

The girdle is like that of *Heterozona*, but the valves and general shape are similar to *Stenoplax*, except that the mucro is posterior and elevated, a character recalling *Callistochiton.*

I. pectinatus Sowerby. Pl. 17, figs. 25–30.

Shell elongated, narrow, elevated; gray, mottled and dotted all over with black, more or less stained in places with pink.

The valves are strongly convex; end valves radiately coarsely granose-ribbed; umbo of posterior valve elevated, situated *behind the center.* Lateral area much raised, having radiating granose riblets; central areas having smaller cords, which are close and longitudinal on the jugum, but become more spaced, coarser, and *diverging* on the pleura or sides of the central areas.

Interior bright pink. Anterior valve with 10–12, intermediate valve 1, posterior valve 8–11 slits. Teeth sharp, frequently bifid; eaves unusually wide, solid, scalloped by the sculpture of the outside. Sutural plates high, rounded. Sinus deep, square.

Girdle (pl. 17, figs. 28, 29) covered with *extremely fine scales* among which *larger, long flat scales are irregularly scattered.*

Length 36, breadth 16 mill.

Length 40, breadth 17 mill.

Cuba (Cuming); *Guadeloupe* (Swift); *Barbados* (Rush).

Chiton pectinatus SOWB., Mag. of Nat. Hist., June, 1840, p. 288, t. 16, f. 3; Conch. Illustr. f. 146.—REEVE, Conch. Icon. t. 26, f. 133.—*C.* (*Ischnochiton*) *pectinatus* SHUTTLEW., Bern. Mittheil. 1853, p. 77.—*Ischnoplax pectinatus* CPR., MS.—*Chiton acutiliratus* REEVE, Conch. Icon. t. 8, f. 46.—*Chiton multicostatus* C. B. AD., Proc. Bost. Soc. N. H. ii, p. 8, 1845.

Readily known from other West India Chitons by its elongated form, speckled and mottled coloring, and especially by the very peculiar girdle. The large scales are distinctly but finely striated. The ground-color of the girdle is pale buff, with patches of olive-green. The large scales are mingled white and buff on the light tracts, and are a dark blue-green on the dark patches.

Reeve's *C. acutiliratus* (fig. 30) is a typical *pectinatus*. I have not seen the *Ch. multicostatus* of C. B. Ad., described from Jamaica, and the description is too meager to permit certainty in referring it here.

Subgenus IV. HETEROZONA Carpenter, 1878.

Heterozona CPR. (Table of Regular Chitons, 1873), DALL, Proc. U. S. Nat. Mus. 1878, p. 331. Type *H. cariosa* Cpr. *MS.*

Shell like normal Ischnochiton; girdle bearing small scales with large striated scales intermingled.

The girdle is that of *Ischnoplax*, but the shell is not elongated, and the umbo of the posterior valve is median, not posterior. The arrangement of scales normal in this section is the same as a pathologic condition sometimes met with in individuals of species *normally* having regular and equal scales, but in which the girdle has been injured; the injury being repaired with scales much smaller than those upon the healthy portions of the girdle.

I. CARIOSUS Carpenter, n. sp. Pl. 24, figs. 20, 21, 22.

Shell oblong, rather elevated, the valves broadly arched and rounded dorsally. Color, soiled yellowish, unicolored or with indistinct brown spots.

The lateral areas are raised, and sculptured with a varying number (about 7) of radial ribs, which are irregular, often splitting, and very unevenly granose. Central areas finely granulated upon the dorsal ridge, the granulation giving place on the side-slopes to a rather strong but fine corrugation; the wrinkles longitudinal, but converging forward toward the middle; and minutely irregular

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or undulating. Toward the outer edges the wrinkles become coarser and more separated. End valves sculptured with radiating riblets; posterior valve having the mucro central. Interior white, the end valves usually marked with a brown crescent; sutural lobes rounded; sinus wide and flat. Anterior valve having 12, median valves 1, posterior valve 12 slits; teeth smooth, rather sharp. Eaves solid.

Girdle covered with flattened striated scales, which are very unequal in size, but become larger toward the valves (fig. 21).

Length 32, breadth 16 mill.

Australia.

The texture of the shell is peculiar, the outer layer being thin and easily broken through, exposing an extremely spongy layer. Carpenter's specimens seem to have been worn so as to expose this layer in places, hence the name *cariosus*. In the normal and unworn specimens before me the outer surfare is scarcely carious though dull and uneven, nor are the eaves spongy. Carpenter's original description is as follows:

Heterozona cariosa (pl. 24, fig. 23). Shell subelongate, rather elevated, the jugum rounded. Mucro median, moderately elevated; whitish-ashen, slightly variegated at the sutures occasionally. Central areas very granose in a young specimen, the granules minute and close toward the jugum, then becoming rugose lines, undulating anteriorly, and widely separated on the sides; the adult shell is carious. Lateral areas having 3–8 deeply but irregularly granose radii, the grains at the sutures large; end valves having 30–40 graniferous radii. Interior: posterior valve with 11, central 1, anterior valve 11 slits. Teeth acute; eaves wide, spongy; sinus large, flat, smooth. Girdle (pl. 24, fig. 23), clothed with normal striated imbricating scales and having long, large striated solid scales scattered here and there. (*Cpr.*)

Length 30, breadth 16¼ mill., divergence 100°.

Australia (Mus. Cuming No. 46).

This shell forms an exact transition between *Ischnoplax* and the true *Ischnochiton*. The mantle resembles *Ischnoplax* in its double series of scales; although if the large ones were plucked out, the latter would be nearly of a normal arrangement, except that they are rather narrow as in *I. castus*. It differs from *Ischnoplax*, not only in not being narrow and elongated, but in having a normal mucro. The species is curiously like *Stenoradsia magdalenensis*,

young, in shape and plan of sculpture, but the scales are not chaffy and the central valves have only one slit. (*Cpr.*)

Carpenter's description and figure differ somewhat from the specimens before me, described above. If the latter proves specifically distinct it may be called *I. subcariosus.*

Subgenus V. Trachydermon Carpenter, 1863.

Trachydermon Cpr., Rep. Brit. Asso. Adv. Sci. 1863, p. 649.—*Craspedochilus* G. O. Sars, Moll. Reg. Arct. Norv. p. 114 (for *C. marginatus* Penn. = *cinereus* L.).—*Boreochiton* Sars (in part), *l. c.*, p. 116 (proposed for *C. ruber* Lowe and *C. marmoreus* Fabr.).—*Chiton*, *Lepidopleurus*, *Leptochiton*, *Ischnochiton* and *Lophyrus* sp., of various authors.

Valves exactly like those of *Ischnochiton*, both outside and within; girdle having the scales very small, close and smooth, Gills from one-half to over three-fourths the length of the foot.

This group was originally proposed as a subgenus of *Ischnochiton*, and the following species referred to it: *retiporosus* Cpr., *interstinctus* Gld., *trifidus* Cpr., *dentiens* Gld., *gothicus* Cpr., *hartwegii* Cpr., *nuttallii* Cpr., *flectens* Cpr. Carpenter subsequently stated that *Trachydermon* was equivalent to Gray's second section of *Ischnochiton*, " ** scales of mantle minute, granule-like." (P. Z. S. 1847, p. 127), this section containing only the species *P. marginatus*= *C. cinereus* L. and Lowe. Still later, Carpenter raised the group to the rank of a genus, adding to his diagnosis the words " gills short." It is evident that a type species for the group should be selected from Carpenter's original list; not from among the species subsequently referred to the group by him. The shortness of the gills influenced Carpenter and Dall to place this group next to the *Leptochitons*, but there is probably no affinity indicated by this character, *Trachydermon* being *phylogenetically* as far from *Leptochiton* as *Ischnochiton* is.

The length of the gill-row is so variable that genera cannot be founded upon that character in the present family. In the species *albus* and *ruber* I have ascertained the gills to be median, as they are said to be also in the *scrobiculatus* and *lividus* of Midd. In the other species which I have examined, or upon which data are available, *interstinctus*, *cinereus*, *dentiens*, the gills extend from two-thirds to over three-fourths the length of the foot.

It is therefore obvious that no separation can be made from other subgenera of *Ischnochiton* on this character.

Several species of *Trachydermon* have distinctly spongy eaves, like those of *Tonicella*. This structure is exceptional in *Ischnochiton* where the eaves as a rule, are solid, as in the genus *Chætopleura*. The fact seems to be that certain forms of Trachydermon, such as *T. ruber*, form a partial transition from *Ischnochiton* to *Tonicella*.

From *Trachydermon*, Carpenter has sundered a few species having Radsioid central valves, to which he has given the sectional name TRACHYRADSIA.

Section *Trachydermon, s. str.*

I. CINEREUS Linné. Pl. 6, figs. 25–31.

Shell oblong, elevated, the dorsal ridge subangular. Anterior valve half-circular, the posterior margin decidedly emarginate. Very evenly and finely sculptured with diamond-shaped granules, which, although somewhat irregular, seem to be formed by the oblique intersection of curved incised lines radiating in two directions from the apex. Intermediate valves having precisely the same sculpture upon both central and lateral areas, the latter slightly raised, but not distinctly separated from the central areas. The posterior margin of the intermediate valves is rather produced or beaked in the middle. Posterior valve decidedly smaller than the anterior, having the umbo low, inconspicuous, and somewhat anterior.

Interior whitish or brown-tinged; sutural plates wide; sinus narrow.

Insertion plates nearly smooth, slightly roughened outside. Number of slits in the anterior valve 9 or 10; in the posterior valve 10 or 12. The teeth of the posterior valve are rugose. The intermediate valves have a single slit on each side.

Color varying greatly, the most common pattern being ashen thickly mottled and blotched with olive; others are a light fleshy-orange, and frequently the light and dark patterns are combined on the various valves of one individual.

The girdle has usually alternating light and dark bars. It is covered with minute scales, the edge having a fringe of delicate glassy spines.

Length 12½, breadth 7½ mill.

Length 18, breadth 10½ mill.

British and Scandinavian Seas, north to Lofoten, south to Bay of Kiel and Vigo Bay.

Chiton cinereus LINNE, Syst. Nat. xii, *teste* Hanley, Ipsa Linnæi Conch. p. 17.—LOWE, Zool. Journ. ii, p. 99, 1825.—FORBES & HANLEY, Hist. Brit. Moll. ii, p. 402, t. 58, f. 1, (*C. marginatus* on plate).—*C. marginatus* PENNANT, Brit. Zool. iv, p. 71, t. 36, f. 2, and of MONT., SOWB., RVE. and JEFFREYS, Brit. Conch. iii, p. 221, t. 56, f. 5; P. Z. S. 1882, p. 669.—*C. marginatus* MEYER & MOBIUS, Fauna der Kieler Bucht, ii, t. 1, f. 1–5.—*Craspedochilus marginatus* SARS, Moll. Arct. Norv. p. 115, t. 20, f. 16; t. 2, f. 2.—*Trachydermon marginatus* CPR., New Eng. Chitons, p. 153.—*Trachydermon cinereus* CPR. *MS.* p. 15.—DALL, Proc. U. S. Nat. Mus. 1878, p. 323.—NOT *Lepidopleurus cinereus* SARS, *l. c.*, t. 7, f. 8.—*Chiton circumvallatus* REEVE, Conch. Icon. t. 27, f. 168.

This species may be known by the evenly shagreened surface, which is quite different from other North Atlantic Trachydermons. *Tr. dentiens* Gld., which Jeffreys considers the same as *cinereus*, differs in sculpture, color, and the shorter form. There are a number of old and more or less doubtful synonyms, such as *Ch. fuscatus* Brown, Ill. Conch. G. B. p. 66, t. 21, f. 17; and Jeffreys quotes also *cimex* Chemn. and *cimicinus* Landt.

Carpenter seems to have supposed that the gills of this species did not extend forward beyond the middle of the foot, but I have determined by the examination of alcoholic specimens, one of which is drawn on pl. 7, fig. 57, that they extend nearly to the head, being composed of 16 or 17 plumes on each side. They are also so figured by Meyer & Mobius. In this character, *cinereus* differs from *albus* and *ruber*, in which species the gills are median.

Carpenter, having examined the type of *C. circumvallatus* Rve., writes that he is satisfied that it is merely a *cinereus*. The locality given by Reeve is no doubt wrong.

Var. *variegatus* Phil. Pl. 7, figs. 58, 59, 60.

Smaller, with triangular sutural laminæ. Anterior valve having 8 or 9, posterior valve having 7 or 8 slits in the insertion plates.

Length 8, breadth 5, alt. 3 mill.

Mediterranean and Adriatic Seas.

Chiton variegatus PHIL., Enum. Moll. Sicil. i, p. 107, 1836; ii, p. 83, t. 19, f. 13.—WEINKAUFF, Conchyl. des Mittelm. ii, p. 412.—ISSEL, Chit. del mare di Genova, Bull. Mal. Ital. iii, p. 7, t. 1, f. 1, 1870.—*Chiton marginatus* Penn., TIBERI, Bull. Soc. Mal. Ital. iii, p. 139, 154.—MONTEROSATO, Enum. e Synon. p. 16, 1878.—BUQ., DAUTZ. & DOLLF., Moll. Mar. Rouss. i, p. 497, t. 61, f. 13–16; t. 62, f. 3.

I have preferred to retain the Mediterranean form distinct, at least as a geographic variety, for it differs from *Tr. cinereus* of the north in being constantly smaller, having fewer slits in the end valves, and having the sutural plates of a decidedly different shape.

I. ALBUS Linné. Pl. 7, figs. 35–38.

Shell oblong, elevated, the back keeled, lateral slopes nearly straight. Anterior valve half-circular, its posterior margin slightly concave; sculpture consisting of some scarcely perceptible, low radiating ridges, often wholly obsolete, and an excessively minute shagreening or granulation of the whole surface, the granules showing a disposition to be arranged in oblique curved lines. Intermediate valves slightly beaked, produced forward in the middle, having the same sculpture, and showing low, irregular growth wrinkles. Lateral areas scarcely raised, sculptured like the front valve. Posterior valve having the umbo slightly elevated, central, inclined backward.

Interior white. Sutural plates large and wide, extending from the insertion plates nearly to the jugum. Sinus rounded.

The anterior valve has 13 slits in the smooth and rather sharp insertion plate; the intermediate valves have one slit; the posterior valve has 10 slits, and the edge of the plate is decidedly roughened and irregular. Another specimen has 14 slits in the anterior valve, 12 in posterior valve; and in still another individual, some of the intermediate valves have two slits on one side.

The girdle is covered with small gravelly scales, and has no marginal fringe of long scales or spines.

The gills consist of thirteen leaflets on each side, extending forward two-thirds the entire length of the foot.

The color is a very delicate buff tint, sometimes almost white, often shading into a light orange on the posterior part and lateral areas of each valve. Most specimens have more or less of a black deposit on the back part of the valves.

Length 15, breadth 7 mill.

Length 10, breadth 5–6 mill.

Arctic and North Atlantic Seas; Greenland; Iceland; Spitzbergen; Scandinavia; British Seas, south to Isle of Man; Gulf of St. Lawrence, Maine, and south to Massachusetts Bay (Cape Cod). In the Pacific from Arctic Ocean, south to the Shumagin Is., west to Kyska. Low water to 337 fms.

Chiton albus LINNE, Syst. Nat. xii, p. 1107.—LOWE, Zool. Journ. iii, p. 80.—SOWB., Conch. Ill. f. 99, 100.—GOULD, Inv. Mass. p. 150, f. 21.—MIDD., Mal. Ross. i, p. 120.—FORBES & HANLEY, Brit. Moll. ii, p. 405, t. 62, f. 2.—STIMPSON, Sh. of N. Engl. p. 28; Inv. of Grand Manan p. 22.—JEFF., Brit. Conch. iii, p. 220; v. p. 199, t. 56, f. 3.—BINNEY, in Gould's Invert. Mass. p. 265, f. 525.—? *Chiton oryza* SPENGLER, Skrift. Nat. Selsk. iv, hft. 1, 1797, *teste* Jeffr.—*Ch. aselloides* LOWE, Zool. Journ. ii, p. 103, t. 5, f. 3.—WOOD, Index Test., Suppl., t. 1, f. 9.—*Ch. sagrinatus* COUTHOUY, Amer. Journ. Sci. xxxiv, p. 217, 1838; Bost. Journ. ii, p. 82.—*Leptochiton albus* H. & A. AD., Gen. Rec. Moll. i, p. 473.—*Chiton* (*Lepidopleurus*) *albus* JEFFREYS Brit. Conch. iii, p. 210.—*Ch.* (*Lophyrus*) *albus* JEFFR. P. Z. S. 1882, p. 669.—*Lophyrus albus* SARS, Moll. Reg. Arct. Norv. p. 114, t. 8, f. 2 (? not t. I, f. 9).—? *Ch. minimus* GMEL., Syst. Nat. xiii, p. 3205.—*Trachydermon albus* CARPENTER, New Engl. Chitons, Bull. Essex Inst. v. p. 153; *MS.* p. 15.—DALL, Proc. U. S. Nat. Mus. 1878, p. 322.

This well known Arctic and subarctic species is intermediate between *Tr. cinereus* and *Tr. ruber* in sculpture. The granulation is much finer than in the former of these, but is on the same general plan.

On pl. 6, figs. 32–34, is copied a Carpenterian drawing of the interior of *Tr. albus*. It is, however, incorrect, the form of head and tail valves being unusual, and the slits of the latter entirely incorrect. The central valve is well represented however. The tail valve of a specimen from Grand Manan, drawn by the writer, is shown in fig. 38 of plate 7, correctly delineating the slits.

I. EXARATUS Sars. Pl. 7, figs. 39–49.

Elongated, oblong-elliptical, strongly convex; valves distinctly obtusely carinated medially. Anterior valve nearly semicircular in front; the posterior edge forming an obtuse reëntrant angle, with a rounded notch in the middle; surface distinctly, radially grooved with single rows of rounded granules between the grooves, becoming larger toward the margin.

Median valves are moderately wide, nearly straight posteriorly, the hinder ones with a slight median beak with distinct diagonal furrows and ridges, dividing them into median and lateral areas; the median areas are covered, on the sides, with fine but very distinct longitudinal grooves, with the intervening ridges narrow and rounded, more or less confluent and broken up into granules, near the diagonal lines towards the median ridge becoming finer and irregular, and finely granulous anteriorly and along the carina. The lateral areas are more elevated and covered with stronger radiating ridges, broken up into oblong and rounded, flattened granules, and separated by narrow radial furrows. The lateral insertion-plates of the median valves project but little beyond the upper lamina; they are sub-truncate, with a thin notch or slit corresponding to the diagonal line above. The posterior valve is transversely elliptical, with the posterior edge evenly rounded; the front area is as in the preceding ones; the posterior area is covered with fine radial and concentric grooves, dividing it into radiating rows of small rounded granules; the articulating plates of its front edge are rather wide, broadly rounded or sub-truncate, and separated by a broad, rounded median sinus; posteriorly the inner surface is marked by about sixteen radiating lines, terminating in thin notches of the inserted edge, which is very narrow and simple.

The marginal membrane is rather narrow and covered with rather stout, prominent, oblong and obtuse spinules, regularly arranged in quincunx, their ends looking like granules, at the edge and on the lower side these are replaced by small slender spinules.

Head rounded; hood large, the sides produced backward into rounded lobes. Foot long and rather narrow. Gills about twenty-four on each side, extending from the posterior end of the foot to about its anterior third.

Length, 17 mm.; breadth, 8 mm.; height, 5.5 mm.; length of shell, 15.5 mm.; breadth, 7 mm.; length 1st valve, 3 mm.; breadth, 6 mm.; length 3rd valve, exposed part, 2 mm.; breadth, 7 mm., length of posterior valve, 3.5 mm.; breadth, 6 mm. (*Verrill.*)

Norway; Off Martha's Vineyard, 101–194 fms.; *off Fernandina, Fla.*

Lophyrus exaratus Sars, Moll. Reg. Arct. Norv. p. 113, t, 8, f. 1; t. II, f. 1, 1878.—*Trachydermon exaratus* Sars, Verrill, Amer. Journ. Sci. xxiv, p. 365, 1882; Trans. Conn. Acad. Sci. vi, p. 208,

t. 30, f. 2, 2*a*, 2*b*.—DALL, Bull. U. S. Nat. Mus. 37, p. 172, t. 45, f. 2.

This species is readily distinguished from T. albus by the very distinct differentiation of the valves into median and lateral areas, having lines of sculpture running in different directions, and by the much coarser granulation of their surfaces. In T. albus there are no distinct lateral areas; the radiating grooves and ridges are absent; and the granulation is so fine and obscure as to be scarcely visible without a lens. The spinulation of the marginal membrane is similar in the two species. (*Verrill.*)

I. DENTIENS Gould. Pl. 8, figs. 61–65.

Shell oval, rather elevated, dorsally angled, ash colored, closely and finely mottled with olive, and having a series of alternating olive and light spots upon the back edges of the valves along the sutures. These spots are often obscure or wanting, and in some specimens the ground color is a pale orange-flesh tint.

The valves are covered with a very minute sharp granulation, the granules small but well raised, and on the central areas of some specimens they are somewhat disposed to be arranged in longitudinal lines converging toward the dorsal ridge, this disposition usually stronger toward the lateral extremities of the valves. The lateral areas are a little raised, the diagonal lines separating them from the central areas rather distinct. The umbo of the posterior valve is median, somewhat raised, the slope behind it being depressed and concave.

The interior is either whitish stained with gray-green, or quite green. The sutural plates do not project as far as usual, and on some valves they are emarginate in front. The jugal sinus is wide, angular, flat or encroached upon by the jugum. The anterior valve has 11 slits in the insertion plate, the intermediate valves 1, the posterior valve has 10 or 12, and some of the median teeth are bifid at the tip.

The girdle is narrow, gravelly, covered with minute scales.

The gills extend to the front end of the foot.

Length 15, breadth 10 mill.

Puget Sound (Gld.); *San Diego, California* (Hemphill, in A. N. S. P. coll.).

Chiton dentiens GOULD, Proc. Bost. Soc. N. H. ii, p. 145; Otia p. 6.—*Ch.* (*Onithochiton*) *dentiens* GLD., *l. c.*, 242; U. S. Expl.

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Exped. p. 321, t. 433 (bad).—*Trachydermon dentiens* DALL, Proc. U. S. Nat. Mus. 1878, p. 323.—*Trachydermon pseudodentiens* CARPENTER, Brit. Asso. Adv. Sci. Rep. 1863, p. 649; Proc. Acad. Nat. Sci. Phila. 1865, p. 60.

This species is closely allied to *cinereus* L., but differs in the sharper granulation, the granules being less regularly arranged, in the form of the sutural plates and the color both externally and within. The girdle of *dentiens* differs from that of *cinereus* in lacking the marginal spicules characteristic of that species. The gills are long, as in *cinereus*.

Gould's diagnosis and figures are extremely incorrect, the light spots along the sutures having been mistaken by him for projections, or "teeth," whence the name *dentiens*. Carpenter ascertained the identity of *dentiens* with the present form by an examination of Gould's type specimen.

A series from San Ignacio Lagoon, Lower California, differs from the San Diego shells in being narrower, chiefly dark green (occasionally with some lighter valves), and in being more subtly granulated. The interior is vivid dark green. One of these is shown in fig. 65. These specimens show a short, slightly acute and beaked umbo on the central valves. In the larger northern specimens this is lost by erosion.

I. GOTHICUS Carpenter. *Unfigured.*

Shell small, much elevated, green, elegantly tinted with rose and olive; valves gothic-arched, the dorsal ridge acute; lateral areas small, arcuately distinctly defined, granulose; umbones prominent; umbonal margin having a tessellated color pattern and incurved. Central areas longitudinally ribbed, ribs rounded, close, not much elevated, the interstices small, sometimes slightly decussated. End valves sculptured like the lateral areas, the tail valve having the umbo median and somewhat elevated.

Interior having the sutural plates scarcely separated, the jugal sinus very broad and shallow; insertion plates of median valves having a single slit, terminal plates with 8–10 slits; the plates are obtuse; eaves hardly elevated.

Girdle most minutely scaly, the granules very close, rounded, smooth; edge with small suberect hairs. (*Cpr.*)

Length 5, breadth 2½ mill.; div. 80°.

Catalina Island, California.

Trachydermon gothicus CARPENTER, Rep. Brit. Asso. Adv. Sci. 1863, p. 649; Proc. Cal. Acad. Sci. iii, p. 212, 1866; *MS.* p. 18.

An unusual character in this very small, prettily sculptured species is that the sutural laminæ are slightly connected [across the jugal sinus] by a layer lining the very broad, shallow sinus. As in *pseudodentiens* [=*dentiens* Gld.] a false appearance of dentation is given to the sutures by the spots of darker painting. (*Cpr., MS.*)

ISCHNOCHITON.

I. RETIPOROSUS Carpenter. *Unfigured.*

Shell small, subelongate, ashen colored; much elevated, the jugum arcuate. Valves subquadrate, apices concealed, lateral areas little defined, having 3 to 6 rounded, obsolete riblets, here and there with acute projecting granules. Central areas pitted all over, interstices small, punctate. Terminal valves with more acute close narrow riblets. Mucro little raised, anterior. Inside with broad sutural sinus. Insertion plates of intermediate valves with one slit on each side, terminal valves with about 12 slits. Girdle bearing close, minute scales, which are little elongated.

Length 11, breadth 7 mill.; div. 90°.

Puget Sound.

Trachydermon retiporosus CPR., Brit. Asso. Rep. 1863, p. 649.—*Ischnochiton* (*Trachydermon*) *retiporosus* CPR., Proc. Acad. Nat. Sci. Phila. 1865, p. 59.

A species like *scrobiculatus* Midd., the central pattern in network, lateral areas with 3 to 6 ribs.

Known to me only by Carpenter's description.

I. FLECTENS Carpenter. *Unfigured.*

Shell small, subelongate, roseate; jugum acute; lateral areas scarcely defined. Valve margins excurved, suture incurved, apices very prominent; valves having minute, not very close granules sparsely subradiating, all over very minutely punctulate. Mucro conspicuous, anterior. Inside: sutural sinus wide, flat; eaves scarcely projecting. Terminal valves with 11, median 1 slit. Girdle very minutely granulate.

Length 8¼, breadth 6 mill.; div. 110°. (*Cpr.*)

Puget Sound.

Trachydermon flectens CPR., Rep. Brit. Asso. Adv. Sci. 1863, p. 649.—*Ischnochiton* (*Trachydermon*) *flectens* CPR., Proc. Acad. Nat. Sci. Phila. 1865, p. 60.

A variety from Catalina Is. has the posterior valve with 7, intermediate 1, anterior 8 slits, the mucro less anterior; divergence 90°. (*Cpr.*)

I. LIVIDUS Middendorff. Pl. 6, figs. 22, 23, 24.

Shell elevated, tegmentum smooth, shining, livid. Anterior valve, lateral areas and posterior valve obsoletely radiately ribstriate. Central areas longitudinally costulate, the riblets separated, sharply cut, whitish, 18–20 in number. Lateral areas depressed. Gills median.

Length 23 mill.; divergence 120°.

Sitka.

Chiton (*Stenosemus*) *lividus* MIDD., Beitr. zu einer Malac. Rossica, i, p. 124, t. 13, f. 3, 4.

This species and the next have not been found by later observers.

I. SCROBICULATUS Middendorff. Pl. 8, figs. 66, 67, 68.

Shell depressed, tegmentum rough, opaque, ashen or yellow-brown. Central areas regularly pitted in longitudinal series; lateral areas swollen, divided by a radiating groove which widens below. Girdle having narrow scales. Gills median, 16 in number.

Length 9 mill.; divergence about 130°.

California.

Chiton (*Stenosemus*) *scrobiculatus* MIDD., Mal. Ross. i, p. 127, t. 14, f. 4–7.

I. SOLIDIOR Carpenter, n. sp. *Unfigured.*

Shell small, oval, somewhat elevated, rather flesh-colored; jugum obtuse; mucro elevated, in front of the middle. Valves pointed, a little rounded at the margins; lateral areas scarcely defined. Entire surface smooth, under a lens minutely roughened and very minutely punctate; wrinkles of growth conspicuous.

Inside: posterior valve with 9, anterior with 8, median with 1 slit; the teeth obtuse, solid, much separated, at times somewhat roughened. Sinus wide, flat; eaves short.

Girdle normal for *Trachydermon*, the granules solid.

Philippines.

This is the only tropical species that I have met with, and it is very abnormal in its stumpy projecting teeth, resembling those of *Tonicella*. The girdle is, however, normal, the extremely minute crowded granules presenting a somewhat bristly appearance under the microscope.

The above is taken from Carpenter's *MS.* The type specimen is Mus. Cuming, No. 10*b*.

I. ASPERIOR Carpenter, n. sp. *Unfigured.*

Shell small, oval, depressed, the jugum acute. Valves apiculate; ashen, maculated with darker. Mucro rather raised, the posterior slope concave. Entire surface under a lens seen to be conspicuously pustulose; central areas having about 7 subparallel lines of small but projecting granules, bending toward the jugum, closer on the jugal area. Lateral areas hardly elevated, having about 3 very distant and a little larger lines of granules; anterior valve with about 18 such lines.

Interior: anterior valve with 8, central valves 1, posterior valve with 9 slits; teeth acute, long; eaves conspicuous, short; sinus narrow, deep, laminated but scarcely dentate. Girdle thickly beset with most minute purple smooth scales (and occasionally corneous hairs, perhaps foreign to it).

Length 11¼, breadth 7½ mill.; div. 140°.

East Asia.

? Trachydermon asperior CPR., *MS.* p. 19.

The solitary specimen was found in a mixed group of species, named *C. pulcherrimus* Sby., and *Lept. craticulatus* by Dr. Gould, and coming from either Hong Kong or Hakodadi. It will be easily recognized by its sculpture and minutely chaffy scales. Whether it belongs to this genus or to *Chætopleura* will probably be decided by the gills. (*Cpr.*)

I. PERORNATUS Carpenter, n. sp. *Unfigured.*

Shell, small, subelongate, elevated; jugum acute; ashen or olive maculated; mucro slightly before the middle, planate. Central areas with subparallel strong tuberculate bars, about 10 on each side, interstices decussated; jugal area granulate, sculptured in front; lateral areas strongly defined, having rounded irregularly radiating tubercles, of which there are around the margin of the posterior valve about 20, the median valves 5, anterior valve 24.

Interior: anterior and posterior valves having 7 slits, median valves 1 slit; teeth a little acute, eaves large, pectinated by the tubercles or little bubbles of the outer surface; sinus moderate, deep, flat, smooth.

Girdle closely beset with rather flat, subpilose, minute scales.

Length 15, breadth 7½ mill.; div. 95°.

Habitat unknown.

? Trachydermon perornatus Cpr., *MS.* p. 19.

Congeneric with *asperior*, but easily distinguished by the very strong sculpture, flattened mucro, yet sharp elevation of the shell. (*Cpr.*)

I. virgatus Reeve. Pl. 8, figs. 72, 73 (enlarged).

Shell oblong-ovate, minute; valves smooth, or under a lens very finely reticulated; beautifully mottled and striped with bluish-green and yellow. Ligament very minutely scaly, marbled. (*Rve.*)

Port Lincoln, Australia.

Ch. virgatus Rv., Conch. Icon. t. 28, f. 192, 1848.—*Trachydermon virgatus* Rv., Carpenter, *MS.* p. 22.—*Ischnochiton virgatus* Rv., Cpr., *MS.* p. 106.

Carpenter writes as follows of the type specimens: Two specimens, Mus. Cuming; minute, length 5, breadth 2 mill.; div. 85°. Shell very arched, the jugum rather obtuse but not very. Mucro elevated, the posterior slope slightly concave. It looks externally like the young of *lentiginosus*, being painted in the same way—olivaceous with bluish-green spots. Girdle tessellated with *very small* scales, *not* striated; granular. The three areas are scarcely to be distinguished. Very conspicuously quasi-granulate all over. The jugular part is partially streaked with brown in one specimen, blotched with ashen in the other. The anterior valve has 9, central valves 1, posterior valve 9 slits. Teeth sharp, few, long. Eaves moderate. Sinus broad, moderate, flat, *not* channelled.

I. virescens Reeve. Pl. 8, figs. 74, 75.

Shell ovate, valves smooth, crenulated along the posterior edge; bright pale green; ligament horny. (*Rv.*)

Habitat unknown.

Chiton virescens Reeve, Conch. Icon. t. 20, f. 126, May, 1847.—"*? ? Trachydermon virescens*" Cpr., *MS.* p. 21.

Carpenter's notes are as follows: Five specimens, no localities, Mus. Cuming. A very remarkable species, with a very singular combination of characters. Perhaps it belongs rather with *gemmea*, etc. Valves rather pointed in front, and broader behind; shell oval, somewhat elevated, jugum rather sharp. Green, with one or more valves always variegated with darker; fine tessellations at sutures, causing it to appear toothed. Mucro rather raised at anterior third; posterior slope very concave. Valves rather curved, with conspicuous, rather obtuse apices. Side areas scarcely distinct. The whole surface is rather glossy, but under the microscope with extremely fine granulation, which runs into fine lines along and near the jugum. Girdle Trachydermoid, covered with extremely minute scales and occasional hairlets, but at the sutures and in a row around the margin are a series of brown dots which turn out to be semi-pores, quite regular but without hairs, only larger grains making a kind of knob. They are very conspicuous as pore-lumps when the shell has been soaked. The anterior valve has 11, central 1, posterior 9 slits. Teeth stumpy, like *nuttallii*, but not striated. Sinus shallow and rounded, with about 16 teeth, formed by the lirations of the anterior part within. Eaves short and very spongy.

Length 12½, breadth 7 mill.; divergence 113°.

I. STRAMINEUS Sowerby. Pl. 8, fig. 71.

Shell ovate, smooth, pale straw-colored; back rounded; marginal scales sparse. (*Sowb.*) Length 10, breadth 6 mill.

Island of Chiloe, under stones at low water.

Chiton stramineus SOWB., P. Z. S. 1832, p. 104; Conchol. Illustr. f. 28; Zool. Beechey's Voyage, p. 150, t. 41, f. 13.—*Trachydermon stramineus* Sowb., CARPENTER, *MS.* p. 21.

Carpenter remarks: A distinct species. Five specimens in Mus. Cuming, much worn and smashed. They scarcely show the sculpture; in the best there is an attempt at granulation. Rather broad, flat, rounded jugum. Girdle gravelly; mucro median, a trifle raised; posterior slope nearly straight. The anterior valve has 15, median 1, posterior 10 slits; teeth sharp, Ischnoid; eaves moderate. Length 11½, breadth 7 mill.; divergence about 114°, the valves rounded.

I. PUSILLUS Sowerby. Pl. 8, figs. 69, 70.

Shell small, obovate, whitish; back elevated; intermediate valves narrow, very minutely punctulate; lateral areas somewhat distinct; posterior valve larger, the apex central, inclined backward. (*Sowb.*)

Length 6¼, breadth 2½ mill.

Pacasmayo, Peru, on a coral reef in 17 fms., 9 miles from shore.

C. pusillus SOWB., P. Z. S. 1832, p. 57; Conch. Illustr. f. 31.—REEVE, Conch. Icon. f. 189.

Carpenter's notes on the two specimens in the Cumingian collection are as follows: Length 5½, breadth 2½ mill.; divergence 90°, nearly semicircular. Small, whitish-ashen, long, arched. No jugum or jugal area. Lateral areas slightly swollen; granulated, but no other pattern. Mucro rather elevated, posterior slope very concave. Posterior valve with 11, median 1, anterior 10 slits. Teeth sharp, long and very thin; eaves conspicuous, not spongy. Sinus deep, broad, flat, not channelled. The shell might pass in sculpture for a young *punctulatissimus;* in shape and size for *Leptochiton cancellatus;* but as far as I can see the girdle scales, they are very minute and like *Trachydermon*, but they have mostly perished, and the specimens have been rather smashed and are in bad condition.

I. RUBER Linné. Pl. 7, figs, 50–56.

Shell oblong, elevated, solid, the back roundly subangular, lateral slopes somewhat convex; surface apparently smooth except for well-marked grooves or wrinkles, indicating growth-periods. Under the microscope, however, an excessively fine reticulation is visible. The color is light buff, marbled all over with orange-red in various patterns, or entirely suffused with reddish; usually having a red dorsal stripe bordered on each side with buff.

The anterior valve is twice as wide as long, crescentic rather than half-round. The intermediate valves are slightly beaked, their lateral areas slightly raised and having stronger concentric wrinkles than the central areas. Posterior valve having a rather elevated but obtuse median umbo.

The interior is *bright pink.* The sutural plates are wide, large; *the jugal sinus is deep, narrow and angular.* The insertion plate of the anterior valve has 8 to 11 slits; intermediate valves normally 1 slit; posterior valve 7 to 11 slits. The insertion plates are sharp and smooth.

The girdle is reddish-brown, covered with minute elongated scales.

The gills extend forward to the middle of the body.

Length 20, breadth 12 mill. Alaskan specimens grow to the length of an inch.

Arctic and northern seas of Europe; south to Massachusetts Bay; N. Pacific and Bering's Sea from Pribiloff Is. west to Attu, south to Sitka; Kamchatka. Low water to 80 fms.

Chiton ruber L., Syst. Nat. xii, p. 1107.—LOWE, Zool. Journ. ii. p. 101, t. 5, f. 2.—GOULD, Invert. Mass. p. 149, f. 24; edit. Binney p. 260, f. 523.—FORBES & HANLEY, Hist. Moll. G. B. ii, p. 399, t. 59, f. 6; t. AA, f. 6.—HANLEY, Sh. of Linn. p. 17.—SOWERBY, Conch. Illustr. f. 103, 104.—REEVE, Conch. Icon. f. 175.—JEFFREYS, Brit. Conch. iii, p. 224; v, p. 199, t. 56, f. 4.—*Ch. cinereus* O. FABR., Faun. Grönl. p. 423, not of authors nor of Linné.—*Ch. minimus* SPENGL., not of Gmel.—*Ch. lævis* LOVEN, Ind. Moll. lit. Scand. p. 28, 1846, not of Mont., Forbes & Hanley, *et al.*—*Ch. lævis* PENNANT (probably), Brit. Zool. (iv), iv, p. 72, t. 36, f. 3.—*Ch. latus* LEACH, Moll. Brit. p. 231.—*Chiton* (*Lepidopleurus*) *ruber* JEFFREYS, Brit. Moll. iii, p. 210.—*Trachydermon ruber* CARPENTER, Bull. Essex Inst. v, p. 153, 1873.—*Boreochiton ruber* SARS, Moll. Reg. Arct. Norv., p. 116, t. 8, f. 4.—*Tr. ruber* DALL, Proc. U. S. Nat. Mus. 1878, p. 320 (1879).—*Chiton incarnatus* REEVE, Conch. Icon. f. 194, 1848.

The shell is apparently smooth, as described by Forbes and Hanley, but under a high power appears finely reticulated as observed by Jeffreys. Its color is very variable, being usually marbled red and whitish like *Tonicella marmorea*, but the valves may be uniform dark red or nearly pure white. I have one specimen with the four central valves dark red and the rest white; one valve in a specimen is often dark red, while all the others are marbled. It is most likely to be confounded with *Tonicella marmorea* and some varieties of *T. lineata*, both of which have leathery girdles, while this species can almost always be determined by its farinaceous girdle, dusted with alternate red and whitish patches, the latter nearly opposite the sutures. (*Dall.*)

I. PUNICEUS Couthouy. Pl. 8, figs. 76, 77.

Shell small, thin, elongated, elliptical, elevated and sharply carinated along the back, of a dull rose, or bright brick-red color, and

everywhere minutely punctured. The lateral areas are very abruptly and distinctly elevated, regularly ridged by the obtusely rounded stages of growth and bearing a few scattered granules. Central areas with the lines of increase well marked, and remarkably barred with about six elevated, longitudinal, parallel ridges, which are generally dislocated about the middle by some of the lines of increase. The posterior valve has a very minute, and acute, nearly central umbo, with an abrupt depression passing transversely through it; the margin is very minutely imbricated by prismatic scales, colored like the shell, and with yellowish bands crossing it, opposite to the junctures of the valves. (*Gld.*)

Length 12½, breadth 7½ mill.

Orange Harbor, Terra del Fuego.

Ch. puniceus (COUTHOUY *MS.*) GOULD, Proc. Bost. Soc. N. H. ii, 1846, p. 143; Exped. Sh. p. 5; U. S. Expl. Exped. Moll. p. 324, t. 27, f. 412; Otia Conch. p. 5.—*Trachydermon ruber var.*, CARPENTER *MS.*—*Lepidopleurus puniceus* ROCHEBR., Miss. Sci. Cap Horn, Moll. p. 140.

The gills extend forward to the middle of the foot. They are erroneously represented upon Gould's plate. Carpenter considered this a synonym of *T. ruber*, but it is probably distinct.

I. STEINENII Pfeffer. Pl. 6, figs. 19, 20, 21.

The form of the animal is a somewhat elongated oval, bluntly rounded before and behind, the middle keel-like and elevated. Girdle covered with granules which are somewhat elongated in a radial direction. Eighteen gills on each side, reaching from the middle of the foot nearly to the posterior end.

Shell rather elevated, very finely granulated. Median valves comparatively narrow, their length not much over ⅓ of their breadth, the posterior angles not produced backward; younger examples having strong, acute apices, older having less projecting blunt apices. Lateral areas separated from central areas by a distinct ridge. Central areas having transverse lines of fine grains, which turn at right angles and become longitudinal on the lateral areas; there are also more or less terrace-like marks of growth-arrest. There is a system of weak radial wrinkle-striæ, converging toward the umbo, upon the central areas, more developed in young specimens, and totally absent in the larger ones. Anterior valve half-round, concentrically finely granulated, and having coarse con-

centric growth-marks. Tail valve half-circular, its latter part sculptured like the head valve; its central area from ¼ to more than ⅓ the length of the posterior slope. Umbo acute in young examples.

The insertion plates are all overhung by the eaves, the latter projecting beyond them. The anterior valve has 17, posterior valve 12 teeth.

The ground color of the shell has a light reddish-white or brilliant red tone, with more or less distinct radiating flamed streaks of lighter and darker; girdle yellowish-brown, lighter toward the edge, with few or numerous transverse tracts of lighter. (*Pfr.*)

Length 26, breadth 14 mill.

South Georgia.

Trachydermon steinenii PFFR., Moll. von Süd-Georgien, in Jahrb. Hamb. Wiss. Anstalten, iii, p. 103, t. 3, f. 1, 1886.

Closely allied to *T. puniceus*, but different in having the central and lateral areas equally granulated, and the central area entirely without longitudinal sculpture.

Section *Trachyradsia* Carpenter.

Trachyradsia CPR., *MS.*—DALL, Proc. U. S. Nat. Mus., Jan., 1878, p. 1, 323. Type, *Ch. fulgetrum* Reeve.

Chitons like *Trachydermon* except that the insertion plates of the median valves have two or several slits.

The species of this group should be carefully compared with *Callochiton* and *Stereochiton*, with which groups they agree in the multiple slits of the central valves and the markedly spongy eaves.

I am not disposed to group these forms with *Trachydermon* but leave them here in deference to the views of Carpenter. It should be noted that Carpenter did not consider *Ch. fulgetrum* the type of his group, that species having been selected by Dall.

I. FULGETRUM Reeve. Pl. 8, figs. 80, 81, 82.

Shell ovate, a little attenuated in front, very minutely and closely decussately punctured under the lens, throughout. Terminal valves and lateral areas of the rest somewhat obscurely radiately grooved. Reddish-brown, peculiarly painted with longitudinal yellow and black zigzag waves. Girdle horny. (*Rve.*)

Habitat unknown.

Chiton fulgetrum REEVE, Conch. Icon. t. xiii, f. 71, March, 1847. —? *Trachyradsia fulgetrum* CPR., *MS.* p. 24.—? *Chiton dentatus*, SPENGLER, Skrivter af Naturhistorie-Selskabet, iv, p. 88, t. 6, f. 16, Kiobenhavn, 1797.

Carpenter writes as follows of the type specimen, unique in the Cuming Collection: The mucro is prominent and median, the slope behind it very concave. The interior is vivid rose color.

The insertion plate of the front valve has 20 slits, median valves 4 to 5, and posterior valve 18 slits. Sinus small, imperfect in each valve, but probably as shown in fig. 81. Eaves small.

Girdle thin, wide, ornamented with small, scarcely imbricating, slightly elongated, very close, deciduous scales.

Length 63, breadth 38 mill.; divergence 103°.

The scales are extremely minute deciduous, crowded into an irregular spongy mass, and when seen separately are not like a flat spine as in *Callochiton*, but somewhat rectangular and scarcely elongate. They have perished over most of the specimen, although that is in fine condition. It appears to have been tessellated with white over the chestnut surface but most of the specimen is now of a light horn color. The radsioid character of the valves and the brilliant rose interior makes this specimen very like *castaneus* but it is known outside by the obsolete riblets formed by slight depressions co-ordinate with the slits inside. Even these do not appear in the younger part of the shell. The color markings are probably variable. It is probably from S. Africa. (*Cpr.*)

I. ALEUTICUS Dall. *Unfigured.*

Shell small, rufous-ashen, oblong, vaulted, the jugum very acute; mucro submedian; apices prominent; lateral areas inconspicuous, entire surface minutely reticulated in quincuncial pattern.

Interior: anterior valve with 16, central with 2, posterior with 11 slits; teeth small, very spongy, widely separated; eaves spongy, sinus small. Girdle beset with minute scales. (*Dall.*)

Length 6, width 3 mill.

Kyska Harbor, Kyska Id.; Constantine and Kiriloff Harbors, Amchitka Id., and Nazan Bay, Atka, in the western Aleutians, at low-water mark, under stones on the beach.

Trachyradsia aleutica DALL, Proc. U. S. Nat. Mus. p. 1, Jan., 1878 and *t. c.*, p. 323.

This modest little species is of a dull livid purplish red, with an ashy tinge, especially on the narrow girdle. Except for the well-marked ridges of growth, it appears smooth, but possesses (like all Chitons) a fine reticulation, only visible under a magnifier. The lateral areas are not distinct, the back is very much rounded and the valves well hooked in the median line. The substance of the valves from within appears remarkably spongy as if rotten, or even like vesicular pumice, especially under the eaves. The anterior slits are marked by radiating lines of holes, though the teeth between them can hardly be made out. The posterior valve, however, has not this aid to counting, and in the general sponginess it is almost impossible to say how many teeth or denticles exist. It bears no marked resemblance to any other species of the region. (*Dall.*)

I. MULTIDENTATUS Carpenter, n. sp. *Unfigured.*

Shell small, reddish-ashen, oblong, vaulted, the jugum very obtuse; umbo of the last valve submedian; apices prominent. Entire surface having the appearance of being minutely scaled in quincunx; lateral areas scarcely distinguishable.

Interior having 20 slits in the posterior valve, 2 or three in the intermediate valves; teeth small, solid, obtuse, deeply and broadly separated; eaves short, spongy; sinus small, very wide, scarcely laminate. Girdle beset with minute scales. (*Cpr.*)

Bonin Islands (Stimpson).

Trachyradsia multidentata CARPENTER, *MS.* p. 24.

The type is in the Smithsonian collection.

The only specimen known has lost its head valve, and most of the mantle scales; what remain of these, however, are of the *Trachydermon* rather than the *Callochiton* type. The shell was named *Lepidopleurus lepidus* by Dr. Gould, but has little in common with that species. There is no character to distinguish it by outside; but within the incisors are represented by a series of roundish, stumpy, peg-shaped denticles, set rather widely apart in the short spongy gums that are characteristic of *Callochiton.* The three or four lobes in the side valves are rather longer. (*Cpr.*)

I. LINDHOLMI Schrenck. Pl. 27, figs. 35, 36, 37, 38, 39.

Shell ovate, about twice as long as wide, depressed; olive-green, the eroded umbones rosy-white. Lateral areas and end valves

radiately costulate, decussated by concentric growth sulci, the riblets more or less scaly-granose, the interstices very delicately punctate. Central areas longitudinally wrinkled, the interstices delicately punctate. Mucro subcentral. Anterior valve having 16, median valves 4, posterior valve 12 slits. Sutural plates yellowish-rose color. Girdle half as broad as the lateral slope of the valves, very delicately granulose, blackish-green maculated with white. Gills ambient, composed of 44 branchiæ.

Length 44 mill.; divergence 130°.

Bay of Hakodadi, Japan.

Chiton lindholmi SCHRENCK, Bull. l'Akad. Imp. Sci. de St. Pétersb. v, p. 511; Mélanges Biolog. iv, p. 253; Reisen u. Forsch. im Amurlande ii, Zool. p. 288, t. 12, f. 9–16.

This large radsioid species may prove to be a *Stenoradsia* (see p. 61); but the meagre description of the girdle given by Schrenck, causes me to place it, for the present, in the decidedly heterogenous group *Trachyradsia.*

Subgenus VI. ISCHNOCHITON Gray (restricted).

Ischnochiton GRAY, P. Z. S. 1847, p. 126.—SHUTTLEWORTH, Bern. Mittheil. 1853, p. 66.—*Lepidopleurus* (part) H. & A. ADAMS, and CARPENTER, *olim.*, not *Lepidopleurus* Risso.—*Ichsnochiton* FISCHER, Manuel p. 880.

Valves having sharp, non-pectinated insertion plates; mucro median or anterior; girdle covered with imbricating scales.

Within this subgenus three subdivisions may be recognized:

Section *Ischnochiton s. s.*, in which the valves and insertion plates are thin and smooth, one side-slit in each median valve; the scales of the girdle flat and striated.

Section *Lepidozona*, differing in the convex, solid girdle scales, which are usually almost smooth.

Section *Radsiella*, like typical Ischnochiton except that there are two or several side-slits in each median valve.

The subgenus *Heterozona* should properly be included here also, and *Ischnoradsia* is not far removed from *Lepidozona* in characters.

Section *Ischnochiton* s. str.

(1.) *Group of I. longicymba.*

Oblong species, with fine, not conspicuous, sculpture, the central areas granulated in quincunx or in zigzag pattern, lateral areas radially ribbed.

The species are from Australo-Zelandic seas.

I. LONGICYMBA Quoy & Gaimard. Pl. 22, figs. 58–66.

Shell oblong, rather highly and broadly arched, not in the least carinated. Surface to the naked eye appearing smooth on the central, radiately lirulate on the lateral areas and end valves. Color extremely variable, usually pale olive mottled with dark olive or purple-black, or having a broad light band along the back.

Lateral areas distinctly raised, sculptured with 8–12 radiating riblets, often bifurcating, the intervals densely granulated; the riblets are interrupted by irregular impressed concentric growth-lines. Central areas very closely and finely granulated in quincuncial pattern; the granulation is nearly even on the jugum, although the anteriorly divergent rows of granules are sometimes slightly more prominent; on the slope between central and lateral areas, and on the extreme sides of the latter the granules are arranged to form more or less distinct longitudinal rows. The end valves are very minutely granulated and radially lirulate. Umbo of posterior valve rather low, obtuse; posterior slope visibly concave.

Interior green or blue sometimes varied with red or corneous. Anterior valve with 9–12, central 1, posterior valve 11 slits; teeth thin, sharp and smooth; posterior tooth of the side insertion plates short, and terminating abruptly before attaining the posterior margin of the valve (figs. 61, 64); eaves solid.

Girdle closely covered with solid, convex but somewhat flattened imbricating scales, most of which are rather weakly striated, but among which non-striated scales are mingled (pl. 22, figs. 63, 66).

Length 33, breadth 16 mill. (often smaller).

New Zealand: Auckland to Dunedin; Pitts' Island; Auckland Is.; Campbell Id.

C. longicymba (? Dufresne, Mus. Paris; Blainville, Dict. des Sci. Nat. xxxvi, p. 542), QUOY & GAIMARD, Voy. de l'Astrol. Zool. iii, p. 390, t. 75, f. 1–18 (1834).—REEVE, Conch. Icon. t. 19, f. 125, t. 24, f. 163d.—*Lepidopleurus longicymbus* HUTTON, Man. N. Z. Moll. p. 113 (1880).

There is no certainty in the identification of de Blainville's *longicymba* but I have accepted the form recognized under that name by Quoy, as he was the first to figure the species. This identification compels us to regard the New Zealand shell as the type form. Figures 58, 60–66 represent New Zealand specimens furnished me by Prof. Hutton and Mr. G. W. Wright. These differ from the Australian form, which I have named *Haddoni*, in the much less distinct, less regular striation of the girdle scales, the broadly rounded arch of the back, and the short, abruptly terminating posterior tooth of the side insertion plates.

I. HADDONI Pilsbry, n. sp. Pl. 22, figs. 67–73.

Shell distinctly keeled on the back; *scales of the girdle beautifully regular in size and arrangement, and evenly and deeply grooved* (fig. 67). Sculpture and color patterns like *I. longicymba.*

Interior white, greenish or bluish; anterior valve with 10, central 1, posterior valve 12 slits; teeth thin, sharp. *Posterior tooth of the intermediate valves long, extending almost to the posterior-lateral angle of the valve, and not terminating abruptly* (fig. 72).

Length 27, breadth 12 mill.

The coloring is even more variable than in the New Zealandic *I. longicymba;* some specimens are clear, light greenish-buff (fig. 71); some are brown, speckled all over with olive-black; some are mainly red, or black, having a wide white dorsal stripe.

Port Jackson, Australia.

Chiton longicymba SOWERBY, Conchol. Illustr. f. 67.—REEVE, Conch. Icon. t. 24, f. 163a–c.—*Ischnochiton longicymba* CPR., *MS.*, and of HADDON, Challenger Rep. Polyplac. p. 17 (not *Ch. longicymba* Quoy).

Having examined extensive suites of specimens of the *longicymba* type of Ischnochitons from New Zealand and Australia, I find myself compelled to separate specifically those from the latter locality, although in general appearance, color and sculpture they certainly resemble the true *longicymba.* The differences indicated above, and shown in the figures, seem to be remarkably constant, and readily recognized if one takes the trouble to look for them. It must be admitted, however, that to thoroughly examine a small Chiton involves some little trouble; and therefore we must feel no surprise if the superficial collector and the often no less superficial author, continue to confound species which are really distinct. It

must be said, however, that the confusion of these two species has probably been due to the lack of specimens from the two localities for comparison; else the differences would hardly have escaped writers so careful and observant as Carpenter and Haddon.

I. CRISPUS Reeve. Pl. 24, figs. 98, 99 (enlarged).

Shell rather elongately ovate; terminal valves and lateral areas of the rest finely decussately granulately crisped, central areas smooth, or under the lens very minutely reticulated. Olive-green, thickly painted with dots of a darker color. Ligament minutely granulously coriaceous, obscurely tessellated. (*Reeve.*)

Australia.

C. crispus RVE., Conch. Icon. t. 19, f. 120, May, 1847.

Allied to *C. longicymba*, but distinguished from that by the minute decussated character of the sculpture of the lateral areas. (*Rve.*)

Carpenter seems to think this simply a pale variety of *C. longicymba*, saying that he cannot see the decussation spoken of by Reeve, unless it is from the concentric ribs of growth seen in some of the specimens.

In view of the inadequate description and figure, the species had better be dropped.

I. PALLIDUS Reeve. Pl. 23, fig. 91 (*enlarged*).

Shell oblong-ovate, valves smooth throughout; dead white; ligament horny, arenaceous, brown. (*Reeve.*)

Australia.

C. pallidus REEVE, Conch. Icon. t. 16, f. 92, March, 1847.—*Isch. pallidus* CPR., *MS.*

Carpenter's notes on the specimens in the British Museum are as follows, but I am not sure that these are Reeve's species: Shell almost exactly like *I. longicymba*, gothic-arched; whitish, ashen, or variously tinged or streaked with roseate, blue and olivaceous; jugal area scarcely defined, jugum obtuse; central areas wrinkle-striated, the wrinkles irregularly tending forward toward the jugum, sometimes v-shaped; lateral areas well-defined, having 12–30 granulate-wrinkled striæ, sometimes the wrinkles, sometimes the granules predominating, sometimes having concentric growth wrinkles. Mucro median, rather elevated, the slope behind it little concave. Interior: front valve with 11, central 1, posterior valve 13 slits; teeth

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acute; sinus very broad, flat; eaves large, scarcely spongy. Girdle thin, irregularly imbricated with very small, very close, solid, subelevated, conspicuously sulcated scales. *Australia.* Five specimens, B. M., the tablet including two specimens of *longicymba* and one of *Heterozona cariosa ?*.

In the first specimen the radiating sculpture is almost lost in the granules in the side areas. The painting is sometimes with delicate broken lines of brown longitudinally. Sometimes one jugular patch more or less broken into streaks, side areas rarely if ever painted, but often tinged with bluish green. The specimen opened B. M. has 2 central teeth on posterior valve changed into an irregular series of pectinations evidently consequent on an injury. (*Cpr.*)

I. INQUINATUS Reeve. Pl. 18, figs. 49, 50 (enlarged).

Shell oblong-ovate; terminal valves and lateral areas concentrically, somewhat obscurely ribbed, finely radiately grooved; central areas longitudinally finely ridged. Ligament horny, arenaceous. Whitish, stained with a light brown spot along the summit of each valve. (*Rve.*)

Tasmania.

C. inquinatus RVE., Conch. Icon. t. 23, f. 154, May, 1847.—*Ischnochiton inquinatus* CPR., *MS.*

The shell is sometimes partially stained throughout with the faint brown color which appears on the umbonal summit. (*Rve.*)

Compare *I. divergens* Rve.

I. DIVERGENS Reeve. Pl. 22, figs. 74–77.

Shell oblong, moderately elevated, varying from obsoletely to distinctly angled at the dorsal line. Lateral areas raised and rugose. Color very variable, but usually a light green tint, spotted with dark olive-brown, or cream-white, variegated with olive, olive-brown or dull scarlet.

The raised lateral areas are sculptured with a varying number of *bifurcating or irregular riblets*, the surface between them being granular. Central areas *sculptured in the middle with very fine subgranose striæ diverging forward ∧-like from the dorsal ridge;* pleura or sides of the central areas having stronger *longitudinal rugæ at the sides and on the diagonal slope;* a region of fine zigzag striation sometimes intervening between the side corrugation and the ∧-like striation of the jugal tract. End valves sculptured like the lateral areas. Umbo

of the posterior valve rather acute, in front of the middle; posterior slope concave.

Interior whitish or bluish, marked at the sinus with blue-green, and posteriorly with rose; the tail valve having a conspicuous black crescent in the middle. Anterior valve having 10–12, central 1, posterior valve 10–13 slits; teeth sharp; eaves narrow, solid.

Girdle indistinctly tessellated with purplish on a paler ground, covered with *large, convex, closely and deeply striated* solid scales (fig. 74). Length 28, breadth 14 mill.

Port Jackson, Australia.

Chiton divergens REEVE, Conch. Icon. t. 8, f. 44.—*Ch. proteus* REEVE, *l. c.*, t. 18, f. 111.—*Lepidopleurus proteus* ANGAS, P. Z. S. 1867, p. 222.—*Ischnochiton divergens* and *Isch. proteus* CPR., *MS.*, *Isch. intricatus* and *Isch. intricandus* CPR., *MS.*, *olim.*

This species differs from *I. longicymba, haddoni* and *fruticosus* in the very much larger convex scales of its girdle. It has the lateral areas much as in *I. fruticosus*, but the median portion of the central area is more distinctly patterned, and the jugum is subcarinated. It varies greatly in coloring, and usually has some rose-pink inside.

I. divergens has been erroneously united to *fruticosus* by Angas and by Haddon. It should be understood that all of the detail drawings of the girdles are drawn to exactly the same scale; if this be considered, the student need not hesitate in identifying the present species.

I. FRUTICOSUS Gould. Pl. 23, figs. 78, 79, 80.

Shell oblong, moderately highly arched, the back rounded, not carinated. Surface lusterless and showing distinct, irregularly radiately roughened lateral areas. Color usually grayish or light green, becoming olive-green or brown toward the sides, and more or less spotted with blackish.

The lateral areas are raised and irregularly sculptured with a varying number (3–6) of bifurcating subnodose radiating riblets, the posterior one of which is transformed into a series of nodes; the other riblets often much interrupted (fig. 80), but sometimes nearly continuous; intervals between the riblets are finely granulated. The central areas are either minutely and evenly shagreened in the middle, much as in *I. longicymba*, except that the granules are more distinctly arranged into

oblique zigzag rows; but toward the sides of the central areas, along the diagonal slope, a coarse sculpture of longitudinal wrinkles is developed. End valves sculptured like the lateral areas; umbo of posterior valve rather obtuse, the posterior slope concave.

Interior white and blue or blue-green; posterior valve having a black crescent. Anterior valve having 10, central valves 1, posterior valve 9 slits. Teeth sharp, thin, smooth outside, but slightly roughened inside; posterior tooth of the side plates terminating abruptly near the posterior edge of the valve. Eaves narrow, solid.

Girdle indistinctly marbled with ashy-purple on a paler ground; very closely covered with microscopic, deeply imbricating striated scales (fig. 79). Length 33, breadth 15 mill.

New South Wales.

Chiton fruticosus GOULD, Proc. Bost. Soc. Nat. Hist. ii, p. 142 (July, 1846); U. S. Expl. Exped. p. 319, f. 428; Otia, p. 4, 242. —*Ischnochiton fruticosus* CARPENTER, *MS.* and of HADDON ? Challenger Polyplac. p. 17.—*Isch. sowerbyi n. s. ?*, CPR., *MS.*

This species has the lateral areas more roughly and irregularly sculptured than *I. longicymba* or *I. haddoni*, and the girdle is somewhat more compactly, flatly scaled than either. The external sculpture of the valves is extremely similar to *I. divergens* Rve., but the latter differs totally in its very coarsely pebble-scaled girdle.

I. SCULPTUS Sowerby. Pl. 23, figs. 89, 90.

Shell subelongate, depressed, subattenuated in front, back rounded. Central areas smooth, striated at the sides; lateral areas ornamented with radiating exfoliating ribs; margin smooth. Length 20, breadth 10 mill. (*Sowb.*)

Habitat unknown.

C. sculptus SOWERBY, Mag. of Nat. Hist. iv, p. 292, June, 1840; Conch. Illustr. No. 44, f. 66.—REEVE, Conch. Icon. no. 177, t. 26, f. 121.

A beautiful little shell, remarkable for the exfoliated sculpture of the lateral areas, on each side of which there are three radiating series of strongly relieved laminæ. The central areas are nearly smooth except at the sides, where they are slightly striated. The margin is nearly smooth, light brown irregularly striped with gray; and the general color is creamy-white. (*Sowb.*)

I. CONTRACTUS Reeve. Pl. 23, figs. 81, 82.

Shell oblong, peculiarly contracted at the extremities especially the anterior; terminal valves and lateral areas of the rest concentrically granulated, granules solitary, central areas very minutely and closely ridged, ridges curved and conspicuous towards the sides, finer towards the middle and decussated with oblique striæ; light bay, flamed in the middle with brown; ligament granosely coriaceous, dark brown. (*Rve.*)

Tasmania (Mus. Cuming)

Chiton contractus REEVE, Conch. Icon. t. 15, fig. 78, March, 1847. —*Chiton decussatus* REEVE, Conch. Icon. t. 18, f. 107, April, 1847. —*Chiton castus* RVE., t. 22, f. 145, May, 1847.—*Ischnochiton castus* CPR., *MS.*, and *I. intergranosus* CPR., *MS.*—*Lepidopleurus speciosus* H. AD. & ANGAS, P. Z. S. 1864, p. 192; *l. c.*, 1865, p. 187.

This species has been several times described, but the range of variation seems to be less than in some other allied forms, although the coloring varies considerable. The acute dorsal ridge, divergent or zigzag sculpture of the dorsal areas, the granulation of the lateral areas and serration of the sutures are characteristic. The descriptions of the several forms included under *contractus* follow below.

Carpenter's notes are as follows: shell oval, subelevated, ashy, irregularly streaked with brown-olive. Otherwise like *I. castus*, but the central areas are everywhere zigzagly wrinkled, the lines which in *castus* are conspicuously at right angles to the diagonal line are not seen in *contractus*. Lateral areas and end valves having close radiating wrinkles, more or less broken into granules concentrically, sometimes scarcely at all, sometimes entirely so. Interior: anterior valve having 14, central valve 1, posterior valve 13 slits; teeth acute; eaves conspicuous, hardly spongy; sinus wide, flat, smooth; it appears broader and the sutural laminæ not so high as in *castus*. Girdle pale black-brown; scales as in *I. castus*. Length 37, width 17½ mill.; divergence 110°.

There are 3 specimens in the Cuming collection, from Tasmania, and two on the same tablet which are really an intermediate variety of *I. castus*. I cannot see the contracted shape figured by Reeve, in either of the specimens, which are shaped just like *I. longicymba*. The streaked coloring is quite exaggerated; it is very irregular, not in even lines as in Reeve's figure. The divergence is the same as in *I. castus*. Side by side they exactly correspond. The difference

in the sinus is perhaps accidental, from their being older specimens. (*Cpr.*)

C. decussatus Reeve. (Pl. 23, figs. 83, 84.) Shell oblong-ovate, a little attenuated posteriorly. Terminal valves and lateral areas grained, the grains rather obtuse, numerous, irregular, interstices rough. Central areas decussated with very close slightly wrinkled striæ. Pale yellowish-green, flamed along the summit with brown. (*Rve.*)

Australia (Mus. Cuming, 1 specimen).

C. castus Reeve. (Pl. 23, figs. 87, 88.) Shell oval, subelongate, rather elevated, orange tinted with red; jugum acute; mucro rather raised, median, the slope behind it concave. Central areas closely wrinkled, the wrinkles at the jugum diverging laterally, sometimes interrupting one another and forming zigzags. Lateral areas and end valves with concentric nodular wrinkles, sometimes the wrinkles, sometimes the nodules predominating; nodose at the sutures.

Interior orange-flesh tinged; front valve with 9, central 1, posterior 13 slits; teeth acute, scarcely pectinated; sinus wide, flat, deep, slightly and very minutely denticulated by the external sculpture; eaves large, hardly spongy.

Girdle olivaceous, slightly tessellated, imbricated with large, wide and solid, *deeply striated* scales. Length 21, breadth 12 mill.; divergence 103°. (*Cpr., from type specimen.*)

Australia.

The general characters of this species are the same as in *textilis* and *cariosus*, but it differs sufficiently in sculpture. Both of the two specimens in the Brit. Mus. are curved up so that they cannot be measured accurately.

Another form which Carpenter described in *MS.* as "*I. castus* n. sp.," but which he afterward decided to be synonymous with *castus* Rve., is white with a black girdle. The shell is much elevated with acute jugum; the central areas have delicate but much raised liræ, about 30 on each side, and subparallel except toward the ridge where they bend outward, and upon the jugum they are elegantly undulating. The lateral areas and end valves have rather large, separated grains, scarcely radiating, serrating the sutures. The anterior valve has 13, central 1, posterior valve 11 slits. The girdle is clothed with narrow, stout, deeply grooved scales. Length 30, breadth 16 mill.; divergence 110°. It is from *Swan River* (Mus. Cuming, No. 100).

Lepidopleurus speciosus. Shell lengthened, tawny, back ornamented longitudinally with red-brown, the margin with a wide concentric green zone. End valves and lateral areas concentrically ribbed, the ribs pustulose, interstices minutely granulated. Lateral areas somewhat elevated. Median valves carinated. Dorsal areas divaricately wrinkle-striated. Girdle pale brown, covered with closely imbricating scales. Length 35, breadth 20 mill. (*Ad. & Ang.*)

Port Lincoln.

This is an excellent description of the exterior of this species.

I. COLUBRIFER Reeve. Pl. 21, figs. 51, 52.

Shell oblong-ovate, somewhat elevated in the middle. Terminal valves and lateral areas peculiarly flat-grained, central areas very finely reticulated with circular and oblique striæ. Whitish blotched with black; ligament scaly. (*Reeve.*)

Habitat unknown.

C. colubrifer REEVE, Conch. Icon. t. 28, f. 188, Jan., 1848.—*Ischnochiton colubrifer* CPR., *MS.*

Carpenter writes: Three specimens, Mus. Cuming. Very like a young variety of the *castus* group. Shell arched, *not* keeled, elevated; ashy, spotted with dark here and there, tinged with orange about the umbos, which are not beaked. Central areas, and the undifferentiated jugal areas, covered with a minute granulation, running perpendicular to the diagonal line and then branching off into wrinkles. Lateral areas and end valves having granulations running into coarse concentric wrinkles. Posterior valve having 10, central valves 1, anterior valve 9 slits; teeth extremely sharp and fine; sinus broad, deep, smooth, deeply channelled at the sides; eaves long, solid. Girdle having typical Ischnoid scales, rather large, flat, broad, thin, regularly imbricated, very finely striated.

Length 16, breadth 7 mill.; divergence about 83°.

I. PALLIDULUS Reeve. Pl. 23, figs. 96, 97.

Shell elongated; terminal valves and lateral areas concentrically undulately wrinkled; central areas minutely rough; whitish throughout; ligament horny, arenaceous, whitish. (*Rve.*)

Habitat unknown.

C. pallidulus REEVE, Conch. Icon. t. 20, f. 131, May, 1847.—*Ischnochiton pallidulus* CPR., *MS.*

Carpenter gives the following notes: Anterior valve with 9, central valves 1, posterior valve 9 slits; teeth typically Ischnoid; sinus deep, broad, channelled, flat; eaves moderate. Jugum obtuse, elevated; central areas very conspicuously granulated in quincunx, passing somewhat into the V-sculpture; lateral areas conspicuously raised, concentrically wrinkled, "thumby." Mucro central. Girdle with pretty large, broad, thin, distinctly striated regularly imbricated scales. Length 22, breadth 10½ mill,; divergence 106°.

The peculiarity of the shell is the elongation. It is probably Australian and belongs to the *I. contractus* group.

I. USTULATUS Reeve. Pl. 24, figs. 11, 12 (*enlarged*).

Shell elongately ovate; terminal valves and lateral areas radiately ridged; ridges wrinkled, here and there grained and bifurcated; central areas very minutely reticulated. Burnt brown. Ligament granosely coriaceous. (*Reeve.*)

Australia.

C. ustulatus REEVE, Conch. Icon. t. 17, f. 102, March, 1847.—*Ischnochiton ustulatus* CPR., *MS.*—*Lepidopleurus ustulatus* ANGAS, P. Z. S. 1867, p. 222.

Carpenter briefly notes that the scales of the type specimens are rather gravelly and irregular, very small, but apparently a little striated. The drawings of scales and valves given on my plate were prepared for Carpenter, presumably from specimens in the collection of Mr. Wm. A. Haines, of New York City.

I. CARINULATUS Reeve. Pl. 23, figs. 94, 95.

The finely keeled Chiton. Shell oblong-ovate, terminal valves and lateral areas of the rest concentrically and radiately somewhat obscurely ridged and sculptured with obtuse granules arranged in wrinkles, central areas also granulated, smooth in the middle, peculiarly keeled at the summit; ruddy rose; ligament finely squamately coriaceous. (*Rve.*)

Tasmania.

Ch. carinulatus REEVE, Conch. Icon. t. 23, f. 158, May, 1847.—*Ischnochiton carinulatus* CPR., *MS.*

Carpenter's notes on the single type specimen in the British Museum are as follows: A long, narrow, rather *pollicaroid* shell, the shape of *longicymba.* Girdle with very small, distinctly but finely striated scales. Mucro at the anterior fourth. Jugum rather

sharp, curiously marked by a long, narrow white line which may be accidental. Central areas having very strongly marked rugose granulations; falling irregularly into corrugations, but made up of grains. Lateral areas moderately raised, with the same grain-wrinkling passing over about four very blunt obsolete ribs; end valves obsoletely radiated. Interior: posterior valve having 11, central valves 1, anterior valve 10 slits; teeth sharp, short, thin; sinus broad but shallow, very straight, smooth, not channelled; eaves moderate, rather close to the teeth. Length 11½, breadth 4¼ mill.; divergence 103°.

I. CURTISIANUS E. A. Smith. Pl. 24, fig. 6 (enlarged).

Shell oval, flattish, of a dirty dark grayish color, having a conspicuous black broadish line from end to end down the middle of the back, with a pale one on each side of it, and with the mantle patched alternately light and dark, irregularly granulated throughout. Valves arched, not carinate at the vertex, with very indistinct lateral areas, exhibiting strong concentric lines of growth, especially conspicuous at the sides and anterior margins. Front plate well curved anteriorly, the posterior margin being broadly sinuated. Second plate longer than the other intermediate valves, slightly incurved on each side, the central outcurved point in front, rather peaked in the middle of the hinder edge. The third, fourth, fifth, sixth and seventh valves are very short in comparison with their width in proportion as 1 is to 3. The jugal sinus is large and arcuate. Last valve of a narrow acutely elliptic form, with the mucro probably near the center. Interior of the plates greenish-blue, stained dark brown in the middle. Laminæ of insertion in the front plate with about ten notches at unequal distances, leaving different sized teeth between them, which are striated on both sides, but more strongly externally, their edges being sharp, but not smooth. The central plates have a single minute notch on each side, the insertion lamina being comparatively smooth on the upper surface and marked with a small brown spot on each side against the edge of the valve. Tail plate much thickened within along the posterior edge, which is roughened by fine cross striæ, there being no prominent teeth, and of course no notches. Mantle margin covered with small subimbricating oval granules. Length without margin 16 mill.; width of fourth plate 9.

The granules of the surface have an irregular concentric disposition, following to some extent the lines of growth. (*Smith.*)

Port Curtis.

Chiton (*Ischnochiton*) *curtisianus* SMITH, Rep. on Zool. Coll. H. M. S. 'Alert,' p. 78, t. 6, f. D. 1884.

This is certainly not a typical *Ischnochiton*. It is difficult, without an examination of a specimen, to refer it to its proper genus.

I. EXIGUUS Sowerby. Pl. 23, figs. 85, 86.

Shell oblong, small, rufescent, narrow. Intermediate valves having a very wide trigonal dorsal carina, the margins grooved; lateral areas distinctly defined. Length 4·1, breadth 1·3 mill. (*Sowb.*)

This is the smallest species Mr. Sowerby has seen; the dorsal keel of the intermediate valves is very broad, and distinguished by a groove on each side. (*Sowb.*)

Lord Hood's Island, Polynesia, on Pearl Oysters.

Chiton exiguus SOWB., P. Z. S. 1832, p. 104; Conchol. Illustr. f. 36.—REEVE, Conch. Icon. t. 28, f. 186.—*Ischnochiton exiguus* CPR., *MS.*

Carpenter writes: Interior: end valves having 14–16 slits, central valves 1 slit; sinus wide, curved; girdle irregularly clothed with large, slightly striatulate scales. Habitat, *Central Pacific* (Pease). Mr. Pease's solitary specimen seems conspecific with Mr. Cuming's hitherto unique specimen from Lord Hood's Island. It is in better condition than the type, but extremely minute and evidently very young.

2. *Group of I. textilis.*

Central areas granulated, becoming striolate at the sides; lateral areas radially wrinkled. South African species.

I. TEXTILIS Gray. *Unfigured.*

Shell *oblong, elongate,* white, pellucid when young, *green with a white central band;* convex above; end valves and lateral areas of the middle valves finely radiately striated and concentrically wrinkled; *central area closely and minutely punctated, and behind finely longitudinally striated;* margin [girdle] white, minutely scaly. Length one inch and a half. (*Gray.*)

Cape of Good Hope (Capt. Carmichael, Mus. Brit.).

Chiton textilis GRAY, Spicilegia Zoologica, pt. 1, p. 5, pl. 6, f. 20 (July 1, 1828).—KRAUSS, Die Südafric. Moll., p. 38.—(?) *Ch. solea*

Sowb., Conch. Illustr. f. 61 (not described, and referred by Sowerby to *textilis*).—Not *Ch. textilis* of Reeve, Conch. Icon. f. 91.

The above description is from Gray's *Spicilegia*, the more important passages being italicised by me. Gray's figure is absolutely worthless. Reeve's figure and description do not pertain to this species, but to *I.* (*Radsiella*) *zebra* Krauss. The true *I. textilis* is in all respects a typical *Ischnochiton*. I refer the undescribed *C. solea* of Sowerby to *textilis* because it is said to be that species by Sowerby himself; but the figure is very poor. The details herein given will enable students to identify Gray's species with comparative ease and certainty, without a figure; for it seems to be closely allied to the *I. oniscus* only among South African Chitons. The details of sculpture of the central areas and the coloring seem to be especially characteristic. Krauss describes specimens collected by him, and which he at one time considered a new species which he intended naming *C. ludwigi*. His description is as follows:

Shell ovate-elongate, semipellucid, subcarinated; white in the middle, the sides ashen-green, often spotted with brown; interior white. Front valve lunate, tail valve rather depressed, submucronate in the middle; intermediate valves having the central areas finely punctate on the ridge, longitudinally striolate at the sides; lateral areas and end valves radiately rugulose-striated. Girdle ashen, submaculated, scaly, the scales small and oblong, *excessively finely multicarinated*. Length 22, breadth 11 mill. Table Bay.

The anterior valve and the posterior part of the posterior valve are radially wrinkle-striated and have 12 slits in the insertion plates, which are smooth and shorter than the eaves. The median valves are rather narrow (8·6 x 3 mill.) and have distinct lateral areas with 5 to 6 strong wrinkle-like and interrupted striæ. The central areas are seen under a lens to be covered with fine raised points, which toward the margins become more and more distinct, and near the lateral margins as well as in front of the lateral areas they unite into distinct longitudinal rows. The sutural plates are rounded; insertion plates short, smooth, and having a single slit. The girdle is covered with extremely small, thin longitudinal scales, not discernable to the naked eye, and prettily marked with 8–9 striæ. The color is whitish in the middle of the shell, grayish-green on the sides, and dotted and flecked throughout with brown.

Krauss also describes the following:

Var. *punctulata.* Shell carinated, ashen-whitish, unicolored or spotted and dotted with brown; very finely punctate. Lateral areas and end valves radially striated. Length 22, breadth 10 mill. The valves are keeled and covered with regularly arranged elevated points only to be seen under a lens.

As an illustration of this variety Krauss refers to Sowerby's Conchol. Illustr. fig. 55, but in my opinion this is not correct.

I. ONISCUS Krauss. Pl. 20, figs. 12, 3, 14, 15.

Shell small, ovate-oblong, thin, semipellucid, subcarinated; white, rarely with a reddish dorsal band, or yellowish with green dots.

Intermediate valves having the central areas very finely punctulate in the middle and longitudinally striolate at the sides; lateral areas and end valves finely undulately striolate. Girdle yellowish, maculated with green, scaly, the scales very minute, oblong, smooth. (*Krauss.*) Length 10, width 5·6 mill.

Natal, on the shore.

Chiton oniscus KR., Die Südafric. Moll. p. 39, t. 3, f. 4.—*Ischnochiton oniscus* CPR., *MS.*

This species, whilst it has a superficial resemblance to *I. textilis* Gray, is readily distinguished under the lens by the smaller and smooth scales and by the smaller number of slits. The valves as well as the girdle appear smooth to the naked eye, but the lateral areas are visible. Under the lens the central areas are very finely punctate on the dorsum, and on the pleura they are longitudinally striated; these striæ continue upon the lateral areas becoming wavy striæ there. The end valves have feeble wavy striæ toward the margins, and have 10 slits in their insertion plates. The intermediate valves are strongly convex, 5 mill. wide, 4 long, rounded at both sides, and having a single slit in each insertion plate. One specimen is white with greenish-brown girdle; another is whitish with a red-brown band along the back; a third specimen is dirty yellow with green dots, the girdle also green dotted. (*Krauss.*)

Carpenter gives this note on specimens received by him from Stimpson: Terminal valves having 10–12, central 1 slit: teeth acute; eaves short, spongy; sinus broad, flat. In one of the specimens examined the hind valve has the central teeth very small and close, while the side teeth are long and distant.

I. YERBURYI E. A. Smith. Pl. 20, fig. 11.

Shell small, depressed, slightly carinated in the middle; pale gray maculated with dull green. Lateral and central areas and anterior valve subequally reticulated all over; apex of the posterior valve subcentral, moderately acute; girdle covered with very minute scales, rosy-gray maculated with dull green. (*Smith.*)

Length 15, breadth 8 mill.

Aden.

Chiton (*Ischnochiton*) *yerburyi* SMITH, P. Z. S. 1891, p. 420, pl. 33, f. 6.

Only a single specimen of this species was found by Major Yerbury. The sculpture recalls that of a thimble. It is a trifle coarser on the lateral, especially along their posterior margins, than on the central areas. The dirty green spotting is also more noticeable on the hinder edges of the valves than elsewhere. (*Smith.*)

I. MACGILLIVRAYI Carpenter, n. sp. *Unfigured.*

Shell elongated, small, elevated, the jugum slightly acute, valves beaked; ashen-brown or pale ashen, often elegantly painted with lines or angular flames. Entire surface minutely granulose; lateral areas scarcely defined, having radiating wrinkles, not very distinct. Mucro median, little elevated. Interior: posterior valve having 12–13, anterior valve 12–11, median valves 1 slit. Teeth subacute; eaves very conspicuous; sinus wide, flat, smooth. Girdle closely covered with delicate, subelongated, strongly lirate scales.

Length 14, breadth 7 mill.; divergence 110°.

Tristan d'Acunha (Macgillivray, Mus. Cuming, No. 74, 92); *St. Paul's* (Mus. Cuming, No. 7).

The specimens from the last locality have the teeth acute.

This shell has the general aspect of *Trachydermon albus* but is longer, not so sharp at the ridge, more highly sculptured, and the scales strongly lirate. The pattern varies greatly in the specimens. It is nearly related to *I. oniscus*, and a larger series of individuals may prove them identical (*Cpr., MS.*)

I. RETICULATUS Reeve. Pl. 20, figs. 16, 17.

Shell oblong-ovate; terminal valves and lateral areas of the rest radiately ridged; central areas rudely and closely reticulated; dull brown; ligament horny, rough. (*Reeve.*)

West Indies (Reeve).

Chiton textilis var. Sowb., Conch. Illustr. f. 61, according to Reeve.—*Chiton reticulatus* Rv., Conch. Icon. pl. 15, fig. 83 (1847). —*Ischnochiton reticulatus* Cpr., *MS.*

Reeve states that this is the *textilis* of Sowerby but not of Gray, and he is probably right, although his own identification of *textilis* Gray is erroneous. Carpenter gives these notes upon Reeve's type specimen: One specimen, which is over-colored and over-drawn in Reeve's illustration. It looks to me like a fine *textilis*, as Sowerby seems to have taken that species, but I have no *textilis* by me for comparison. It is very light brown, with little black irregular dots which appear to be adventitious. Girdle typically Ischnoid, with moderate-sized striated imbricating scales. Fine radiating ribs on the lateral areas, very numerous on the terminal valves; honeycombed in the middle; jugum very much rounded. Anterior valve with 14, central valve 1, posterior valve 12 slits; teeth sharp; sinus very broad and flat, not toothed. Length 30½, breadth 16 mill. (*Cpr.*)

Compare *textilis* Gray, from which this differs in coloration and apparently in sculpture.

3. *Group of I. rissoi.*

Small species having longitudinal riblets upon the central areas, and continuing backward over the lateral areas. These are closely allied to the group of *I. striolatus.*

Distribution: Mediterranean, African and West Indian.

I. rissoi Payraudeau. Pl. 20, figs. 1–7.

Shell oblong, elevated, the back regularly arched or subcarinated, side slopes convex. Surface longitudinally lirate on the intermediate, concentrically on the end valves. Color pale brown-olive, the lateral areas and end valves more or less maculated with snow-white and brown.

The lateral areas are moderately raised and sculptured with coarse, flat, uneven-edged longitudinal riblets, which are separated by narrow punctate intervals and are frequently irregular; under a higher power of the microscope the surface appears to be minutely punctate, the dots whitish. The central areas have close, fine riblets in the same direction, somewhat finer on the dorsal ridge, and giving way to a minute punctation in the region of the beak of

each valve. The umbo of the posterior valve is central and moderately elevated.

Interior white; sutural plates small, separated by a very wide, flat sinus. Anterior valve having 13, posterior valve 10 slits, central valves 1 slit; teeth sharp; eaves narrow, short, solid.

Girdle covered with close, very small, striatulate, imbricating scales. Length 15, breadth 8 mill.

Mediterranean and Adriatic Seas.

Chiton rissoi PAYR., Moll. Corse, p. 87, t. 3, f. 4, 5 (1826).—PHILIPPI, Enum. Moll. Sicil. i. p. 107.—CAPELLINI, Journ. de Conchyl. (2) iii, p. 322 (1859).—ISSEL, Intorno ai Chiton del mare di Genova, in Bullettino Malacologico Italiano, iii, p. 5, t. 1, f. 2, 3 (1870).—MONTEROSATO, Journ. de Conchyl. 1878, p. 147.—BUQ., DAUTZ. & DOLLF., Moll. Mar. Rouss. p. 495, t. 61, f. 10, 11, 12; t. 62, f. 2.—*Ch. meneghinii* CAPELLINI, Journ. de Conchyl. (2) iii, p. 325, t. 12, f. 1.—*Ch. mediterraneus* "Gray *MS.*," REEVE, Conch. Icon. t. 23, f. 157 (1847).

This species is well characterized by its flat close concentric riblets and the sparsely scattered snowy spots on the end valves and lateral areas. The sculpture of the lateral areas is irregular and variable, the riblets being ragged-edged and occasionally subobsolete, leaving the raised areas almost smooth. The *C. polii* Phil. is readily distinguished from this species by its differently formed posterior insertion teeth; in *rissoi* the posterior teeth are normally Ischnoid.

The *Ch. mediterraneus* of Reeve is simply a synonym of the typical form of this species. The form which Reeve calls *rissoi* (C. Icon. t. 19, fig. 122) is a synonym of the variety *meneghinii*.

Var. *meneghinii* Capellini (pl. 20, figs. 8–10). Sculpture stronger, the end valves and lateral areas exhibiting distinct radiating striæ.

Var. *fragilis* Monts. (Enum. e Sinon.). Smaller in size, the sculpture obsolete, without trace of radiating striæ.

I. PERTUSUS Reeve. Pl. 20, figs. 18, 19.

Shell oblong-ovate, valves elevated in the middle, very closely grooved throughout, ridges of the central areas thin, converging towards the umbones, interstitial grooves pricked, posterior edge of the valve serrated; dark red, sprinkled with a few minute white dots; ligament horny, very sparingly beset with short bristles. (*Rve.*)

The pricked interstices between the close-set ridges which constitute one of the distinguishing features of this species are scarcely discernible without the lens. (*Rve.*)

Simon's Bay, Cape of Good Hope.

C. pertusus Rve., Conch. Icon. pl. xvi, f. 88 (1847).—*Ischnochiton pertusus* Cpr., *MS.*

Carpenter's notes from two specimens in the Cuming collection are as follows: The figure in Reeve does not represent it well. It is one of the *rissoi* group. Shell much arched, elevated, but the jugum rather blunt. Umbo of posterior valve raised, situated at the anterior third; the slope behind it very slightly concave, nearly straight. Girdle with Ischnoid scales, but small, long, somewhat imbricating and striated. Color olivaceous, variegated. Jugal area not defined from the central areas, which are sculptured with very numerous and fine rather blunt lirulæ with extremely small interstices; or the surface might be described as finely grooved. These small riblets are longitudinal, very slightly granose, and at the diagonal border of the lateral areas become rugulose, passing on to join with the riblets of the latter. The lateral areas have about 9 to 12 very fine radiating riblets which are made granose by the longitudinal riblets from the central areas crossing them. The end valves have very close and regular radiating rows of grains, the sculpture being very like that of *catenulatus*, but in that species the concentric wrinkles predominate. The head valve has 12 slits, median 1, posterior valve 9 slits. Teeth quite sharp, with long projecting eaves, which are not spongy. Sinus broad, rather deep, flat, smooth, but deeply channelled on each side at the inner bases of the sutural plates. Terminal valves stained with brownish-purple inside.

Length 32½, breadth 16½ mill.; divergence 113°.

I. erythronotus C. B. Adams. *Unfigured.*

Shell small, subelongate, [convex, not carinated]; yellow-white, [the back] irregularly maculated with red; lateral areas ribbed, the ribs nodulous; dorsal areas [sulcate-] striated; girdle scaly [yellowish-white, maculated with ashen]. Length 13¾, width 7½, mill. (*Ad.*)

Jamaica (Adams); *St. Thomas and Porto Rico* (Blauner).

Chiton erythronotus C. B. Ad., Proc. Bost. Soc. N. H. 1845, p. 9. —*C.* (*Ischnochiton*) *erythronotus* Shuttlw., Bern. Mittheil. 1853, p. 76.

The passages in brackets of the above diagnosis are Shuttleworth's interpolations.

I. LATERITIUS Shuttleworth. *Unfigured.*

Shell elliptical-oblong, convex; brick colored, sparsely maculated with whitish; end valves subconcentrically lineate and punctate. Median valves not carinated; central areas irregularly foveolate-impressed, becoming transversely costulate-subsulcate at the sides; lateral areas subelevated, radiately subsulcate and minutely punctate-foveolate. Girdle unicolored red, densely beset with minute flattened scales. Length 12, breadth 6 mill. (*Shuttlw.*)

St. Thomas, West Indies.

Chiton (*Ischnochiton*) *lateritius* SHUTTLW., Diagn. n. Moll. in Bern. Mittheil. 1853, p. 75.

I have not identified this species, of which Shuttleworth writes: I have two specimens. The color is an intense brick-red, both inside and out. It is allied to *C. erythronotus* C. B. Ad., but differs abundantly in the sculpture and color, and in the less elongated shell.

4. *Group of I. striolatus.*

Small species, apparently smooth, but under a lens showing a sculpture of longitudinal riblets or lines of granules on the central areas, interrupted on the lateral areas, which are roughened by peculiar irregular impressions (pl. 18, figs. 54, 55). It is difficult to describe the sculpture of the lateral areas of these species; it is what Carpenter called "thumby" or "pollicaroid."

Distribution: Antillean and Panamic provinces.

Species with striated scales.

I. STRIOLATUS Gray. Pl. 20, figs. 20–24.

Shell oblong, moderately arched, the back sometimes distinctly, sometimes scarcely visibly keeled; side slopes convex. Surface showing no sculpture to the naked eye, but having the lateral areas moderately distinct. Color excessively variable but generally either olive-green or olive-slate colored with white or creamy flecks; or cream-colored, minutely mottled with light brown. The posterior edge of each valve is dotted with light and dark, forming a sutural articulation.

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Lateral areas slightly raised, sculptured longitudinally with *narrow zigzag grooves, the elevations between them flat, and seen under a powerful lens to be most minutely pustulate,* the pustules whitish. Central areas covered with *an excessively fine, close quincuncial granulation which becomes slightly coarser toward the sides, where the granules gradually become merged into longitudinal rows giving a lirate appearance to the pleura,* especially to the part lying at and immediately in front of the diagonal line. End valves having concentric zigzag grooves and a minute granulation, like the lateral areas; posterior valve having a moderately elevated, central umbo, posterior slope concave. Interior light gray-blue or white; anterior valve with 9, central valve 1, posterior valve 9 slits. Teeth smooth, sharp. Eaves narrow, solid; sutural plates whitish, rather wide and low; sinus flat, angular.

Girdle whitish clouded with blue, or blue marbled with white, generally having some small yellow or orange flecks. It is densely covered with imbricating, deeply striated scales. (Pl. 20, fig. 24.)

Length 14 to 15, breadth 8 mill.

St. Thomas; Barbados.

Chiton striolatus Gray, Specil. Zool. p. 6 (1828).—Reeve, Conch. Icon. t. 22, f. 144.

The coloring of this species is extremely variable, and the sculpture, while it is unmistakable when seen under a sufficiently high power, still varies considerably. The side areas and end valves are generally sculptured with the concentric zigzag grooves described above (fig. 23); but occasionally these become so irregular and broken that the surface appears coarsely granulous or scaly. The West Coast species *dispar* Sowb. and *adamsii* Cpr., as well as the *roseus* of Sowerby, all belong to the *striolatus* group, and are closely allied in sculpture. There are also a number of described West Indian Ischnochitons which seem to be either mere synonyms of *I. striolatus*, or closely allied forms, the exact status of which it is quite impossible to fix with certainty until the original types can be examined by a competent person, thoroughly acquainted with the subject. The original descriptions of these forms here follow.

C. squamulosus C. B. Adams. Shell olivaceous, ornamented with a pale green dorsal line; lateral areas covered with prostrate

unequal scales; central areas nearly smooth in the middle, puncto-striate; girdle finely scaly, alternately ashy-greenish and green.

Length 17½ breadth 10 mill. (*Ad.*)

Jamaica.

Chiton squamulosus Ad., Proc. Bost. Soc. Nat. Hist. ii, p. 8 (1845). —*C.* (*Isch.*) *squamulosus* Shuttlw. Bern. Mittheil. 1853, p. 76.

This is unquestionably the same form I have described above as *striolatus*. The name *squamulosus* will therefore become a synonym.

C. lutulatus Shuttlw. Shell small, elliptical-ovate, somewhat narrower in front; dull olivaceous spotted with white; terminal valves impressed-punctate, toward the margins irregularly concentrically subcostulate; jugum not keeled; dorsal areas finely and regularly impressed-punctate, and toward the margins flexuously and irregularly transversely plicatulate. Girdle olivaceous and spotted with white, the scales small, flattened, imbricated. Length 12, width 5 mill. (*Shuttlw.*)

Porto Rico.

Chiton (*Ischnochiton*) *lutulatus* Shuttlw., *l. c.* p. 76, 1853.

This was described from a single specimen, and said to differ from *C. squamulosis* in being narrower with more regular sculpture. I have no hesitation in considering it an absolute synonym of *I. striolatus*.

C. carribæorum (Cpr.) Smith. (Pl. 20, figs. 25, 26). Shell lengthened-oval, scarcely carinated, variedly painted, grayish-olive, white, reddish and olivaceous, or purple, sometimes blackish with white markings; end valves concentrically and roughly granose striate or scaly, central areas ornamented with delicate, curved, flexuous, granose liræ; lateral areas roughly granose or scaly. Posterior valve slightly concave behind the central apex. Girdle minutely scaly, covered with elongate oval scales pale rosy-gray, tessellated with diluted black. Length 27, diam. 9 mill. (*Smith.*)

St. Thomas; Fernando Noronha.

The above appears to be a manuscript name attached to specimens in Cuming's collection which are identical with few shells from Fernando Noronha. The color is very variable, some specimens, when viewed from a distance of twelve inches, appearing olive-gray, speckled with white; others are of a pinkish cream color speckled with red or blotched along the sides in front of the

lateral areas with black, as in some of the specimens from Fernando Noronha. The granules or scales of the lateral area and on the front and posterior valves are peculiarly flat and are somewhat transversely arranged on the former and concentrically on the latter. The central areas are finely punctured along the center, and become more and more coarsely granosely lirate as the sides are approached. One example is almost entirely reddish purple, and others are blackish with a broad pallid stripe down the middle from end to end. (*Smith.*)

Chiton (*Ischnochiton*) *caribbæorum* CPR., *MS.*, SMITH, Journ. Linn. Soc. Lond., xx, p. 496, t. 30, f. 5, 5*a*.

The dimensions given by Smith may possibly be a mistake, for the size mark on his plate is only 13½ mill. long. In other respects the description and figures indicate no tangible points of difference from the *I. striolatus*.

Carpenter's original description of *carribæorum* is before me, and it is an excellent word picture of some of the St. Thomas specimens of *striolatus*. It is worthy of note that Carpenter recognized the specific identity of *striolatus*, *caribbæorum*, *jamaicensis* and *squamulosis*, in one of his later notes.

I.(*? caribbæorum var.*) *jamaicensis* Cpr. Smaller than *caribbæorum*, the lateral areas scarcely defined.

Length 7½, breadth 4, alt. 1¼ mill. Habitat, Jamaica.

I. (*? jamaicensis*) *viridior* Cpr. Larger than *I. jamaicensis*, green, variously maculated with olive; interior: posterior valve having 8, anterior 9, central valves 1 slit. Length 11¼, breadth 7 mill.; divergence 100°. There is no character but size and color by which this solitary specimen can be distinguished from the Jamaican shells. (*Cpr.*)

The specific identity of these two *MS.* forms with *I. striolatus* was conceded by Carpenter.

I. funiculatus Carpenter. Shell small, strongly oval, subelevated, the jugum little acute; pale ashen, ochraceous or olivaceous variegated; mucro central, moderately prominent. Entire surface wrinkled and minutely pitted; wrinkles subregular, nearly parallel with the dorsal ridge on the central areas, about 18 on each side, obsolete toward the jugum; the moderately distinctly defined lateral areas and the end valves undulated and having subobsolete radiating lirulæ. Interior: posterior valve with 7–9, anterior valve

7–10, central valves 1 slit. Teeth acute; eaves moderate; sinus wide, flat. Girdle furnished with very close, deeply striated, flattened scales. Length 10, width 5 mill.; divergence 95°.

Guadaloupe (Mus. Cuming, No. 44).

One specimen is of a pale yellowish tint slightly variegated with a brighter color; another is more ashy and with the variegations of pale olive. It has stronger sculpture than *I. căribbœorum*, the rugulæ rising up like close rungs in a rope-ladder, and dentating the sutures. (*Cpr.*)

The above description, from Carpenter's *MS.* defines a form which will probably prove to be a variety of *I. caribbœorum*, with which species Carpenter, at a later date, united it.

I. PRUINOSUS Gould. Pl. 21, figs. 27, 28.

Shell small, elongated, nearly elliptical, convexly elevated, subcarinate, or rather somewhat doubly carinate along the back; surface generally covered with microscopic punctures, arranged in lozenge. Lateral areas very slightly raised, and longitudinally imbricate-sulcate; central areas with faint lines of growth and punctures in quincunx; anterior valve concentrically striate, not punctate; posterior valve slightly umbonate, and crossed by a transverse ridge, behind which it is concentrically striate. It is frosted or mottled with dark brown, ash, purple, green, &c. Margin minutely granulated, so as to look hoary. (*Gld.*)

"Some specimens are of a uniform pale green. Margin clouded with dark green; some had two or three distinct, white blotches on the sixth valve, the rest of the shell being olive-green, with a line of faint green along middle of back; another had the ground-colour a clear olive, three dark brown spots bordered with white on each side of posterior margin of valves, a row of similar spots surrounding the terminal valves just above insertion, and the whole surface sparsely and irregularly spotted in the same way, so as to present a delicately mottled aspect. A fourth variety was of a uniform dark rose-color, and the margin clouded with dark red bands. Internally it was dark red or rosy along the middle, and dull yellow towards the sides. All the other varieties were of a pale greenish hue internally." (*Couth. in Gld.*)

Length 17½, breadth 8¾ mill.

Off Fort Santa Cruz, Rio Janeiro, on stones in 2 or 3 fms.

C. pruinosus Gld. Proc. Bost. Soc. N. H. ii, p. 144, July 1846; Otia Conch. p. 5, 242; U. S. Expl. Exped. p. 316, f. 419.—Rochebrune, Polyplax. Cap Horn, p. 141.—*Ischnochiton pruinosus* Cpr. *MS.* p. 77, 103.

Carpenter seems to consider this the same as *caribbæorum* and *striolatus;* but the specimen before me is too worn to enable me to decide.

I. regulatus Sowerby. Pl. 21, figs. 53–57.

Shell oblong, rather smooth, olivaceous varied with white; front valve, lateral areas and posterior valve concentrically undulately wrinkled; central areas smooth, wrinkled at the margins. Length 20, breadth 10 mill. Girdle granose. (*Sowb.*)

Puerto Portrero and Inner Lobos Id., Central America, under stones at low water.

Chiton rugulatus Sowb., P. Z. S. 1832, p. 58; Conchol. Illustr. f. 42, 78, 143, 144; Beechey's Voyage, Zool. p. 150, pl. 41, fig. 18.—Reeve, Conch. Icon. t. 19, f. 118; t. 20, f. 128, 133.—*Ischnochiton rugulatus* Cpr., *MS.*

Carpenter describes the interior and girdle from the type specimen, thus: Posterior and anterior valves having 9, central valves 1 slit; teeth solid; eaves moderate; sinus wide, flat. Girdle closely imbricated with moderate sized solid scales, scarcely striated.

It is very like *striolatus* but having stronger sculpture. It goes through all the color variations of *longicymba*. The scales seem to be smooth, but here and there are slight striolations from the dried skin.

I. catenulatus Sowerby. Pl. 21, figs. 47, 48.

Shell long and narrow, elevated, arched, the jugum rounded. Girdle smooth, broad, thin, with imbricating striated scales. Mucro central, elevated, the posterior slope somewhat concave. Central areas sculptured with very close parallel lirulæ, which pass into wrinkles on the lateral areas, which are swollen. End valves concentrically wrinkled. Interior: posterior valve having 10, central 1, anterior valve 9 slits; teeth long, sharp, thin; eaves moderate, not long, but well developed; not spongy. Sinus broad, deep, smooth, channelled. Length 17, breadth 7 mill.; divergence about 102°. (*Cpr.*)

Inner Lobos Island, Peru.

Ch. catenulatus SOWB., P. Z. S. 1832, p. 104; Conch. Illustr. f. 145.—REEVE, Conch. Icon. t. 20, f. 130.—*Ischnochiton catenulatus* CPR., *MS.*

The single specimen before me is whitish, sparsely variegated with brown, the girdle ashen-bluish. The sculpture of the valves is more like that of *I. striolatus* Gray and *adamsii* Cpr., than anything else, having exactly the same pattern, but not quite so distinct. The girdle has conspicuously striated scales.

* * *Species with convex, smooth scales.*

The following species were referred by Carpenter to "Lepidopleurus," but they are closely allied to the present group.

I. DISPAR Sowerby. Pl. 18, figs. 47, 48.

Shell oval, smooth, ashen varied with whitish and black. Central areas smooth, posteriorly longitudinally subsulcate; anterior valve, lateral areas, and posterior area of the posterior valve granulous. Girdle granose. Length 25, breadth 12½ mill. (*Sowb.*)

Island Saboga, Bay of Panama, under stones on the shore.

Chiton dispar SBY., P. Z. S. 1832, p. 58; Conchol. Illustr. f. 25.—REEVE, Conch. Icon. t. 18, f. 96.—Not *Ischnoradsia dispar* Carpenter *MS.*—*Chiton proprius* REEVE, Conch. Icon. f. 161.—*C. picus* REEVE, Conch. Icon. t. 25, f. 121.

The name has been suggested by the circumstance of the central areas being quite smooth, while the lateral areas are covered with granules. (*G. B. Sowerby.*)

The description given by Sowerby differs entirely from the species which I take to be the *Ischnoradsia dispar* of Carpenter's *MS.*, and indicates a form very similar to Carpenter's *L. adamsii.*

Carpenter writes of the type of *C. proprius* Rv. as follows: One specimen, smashed; "West Coast of America," Dr. A. Sinclair, R. N. This is exactly like the *Lepidopleurus dispar,* having very large, smooth scales. Reeve's *C. picus* is also said by Cpr. to be a synonym for *I. dispar.*

I. ADAMSII Carpenter. Pl. 18, figs. 51, 52, 53, 54, 55.

Shell resembling *L. dispar;* pale red-brown, irregularly streaked and maculated with darker, sometimes ornamented with white spots at the diagonal region. Jugum scarcely acute; central areas and terminal valves conspicuously granulous; lateral areas irregularly

warted, the warts lobed. Mucro anterior, slightly conspicuous. Interior having the central valve with 1 slit, end valves 8–10 slits. Eaves small; teeth acute; sinus flat, very wide. Girdle imbricately scaled. Length 15, breadth 7½ mill.; divergence 110°. (*Cpr.*)

Panama.

Lophyrus adamsii Cpr., P. Z. S. 1863, p. 24.—*Lepidopleurus adamsii* Cpr., P. Z. S. 1865, p. 274.

The shells which I have drawn in figs. 51–55 of pl. 18, seem to me to belong to this species rather than to *I. dispar*. They are described below. It must be understood that the more minute sculpture can be seen only under a compound microscope or a very powerful lens.

The shell is oval, rather low, the jugum rounded, side-slopes nearly straight. Color dark olive mottled with lighter, or having large whitish tracts on some valves; the interior light blue, *sutural plates white*. The central areas are closely sculptured with very minute pointed whitish granules, arranged in oblique lines at the jugum (fig. 52) but toward the sides or pleura a system of shallow grooves with granulous inter-ridges curve forward from the diagonal line, as shown in fig. 54, and at the left side of fig. 55. The lateral areas and terminal valves have a coarsely reticulated pattern, formed by impressed zigzag or irregularly lobed impressions, over which a fine granulation extends (fig. 55.)

The interior has 8–10 slits in the posterior valve, 1 in the intermediate valves (fig. 53). Teeth sharp, smooth; eaves very narrow. The girdle was denuded of nearly all of its scales in both of the specimens before me, but such as remain are large, solid.

Length 14, breadth 8½ mill.

I. tenuisculptus Carpenter. *Unfigured.*

Shell similar to *L. adamsii;* olivaceous, minutely variegated with paler and darker color. Entire surface minutely granulose; lateral areas scarcely defined; sutures spotted with white; mucro anterior, rather conspicuous, the slope behind it concave. Interior as in *L. adamsii.* (*Cpr.*)

Panama.

Chiton dispar C. B. Ad., Cat. Panam. Sh. no. 373 (part).—*Lepidopleurus tenuisculptus* Cpr., P. Z. S. 1865, p. 275.

A variety is paler, tinged with rufous at the jugum.

The outside of this shell so much resembles the young of *Chiton stokesii* that specimens may have been distributed under that name. Very few individuals were found. A few striated scales lie loose on the type specimen, probably from one of the other species. In the only place in which they lie *in situ*, they are quite smooth. (*Cpr.*)

I. ROSEUS Sowerby. Pl. 21, figs. 49, 50.

Shell ovate-oblong, smooth, roseate; back rounded; front valve and lateral areas of the intermediate valves longitudinally, central areas transversely sulcate; posterior valve with central apex, concentrically sulcate. Length 17½, breadth 7½ mill. (*Sowb.*)

I. of Plata (Cuming); *Fernando Noronha* (Challenger Exped.), *Peru* (Bradley, in Mus. Yale College.)

Ch. roseus SOWB., P. Z. S. 1832, p. 58; Conch. Illustr., f. 14.—REEVE, Conch. Icon., t. 25, f. 119.—DESH. in Lam., An. s. Vert., vii, p. 498 (not *Chiton roseus* Blainville, Dict. Sc. Nat. xxxvi, p. 553, 1825, a species of Acanthochiton).—*Ischnochiton roseus* CPR., *MS.*—*Ischnochiton boogii* HADDON, Chall. Rep., Polyplac., p. 15, (1886.)

There is not the shadow of an excuse for the change of name made by Haddon, as Blainville's prior *C. roseus* belongs to a genus universally admitted to be distinct. The west coast locality is doubted by Haddon, but it is supported by specimens in the Yale College collection.

Carpenter gives the following notes on this species: Valves and plates very thin, subdiaphanous; mucro median, little elevated. Interior: post. v. with 8, central v. 1, ant. v. 11 slits; teeth very acute; eaves very slender, moderately projecting; sinus large, flat, high, scarcely laminate; sutural plates small, subtriangular. Girdle imbricated with minute solid, *smooth* scales, with bristles interçalated at the margin. The sutural laminæ are as small as in *Leptochiton*, and look like a mere prolongation of the insertion plates round the corner. The scales though normally shaped and arranged, are so minute that Deshayes placed the species in the Tonicioid group.

Haddon writes of *I. roseus* (under the name *I. boogii*), as follows: The locality attributed, on the authority of Cuming, to this species, made the identification with it of a Chiton from Fernando Noronha very doubtful; a shallow-water species was not likely to live in both the Atlantic off Brazil and in the Pacific off West Columbia, with

the whole breadth of South America between. That the Challenger specimen is identical with the British Museum specimens is beyond doubt. May not the difficulty find solution in the fact that the "I. of Plata," as it stands on Cuming's tablet in the British Museum, and to which Sowerby (loc. cit.) added "W. Columbia" is really some island in the estuary of La Plata?

The above criticism was first suggested to me by the Rev. R. Boog Watson, to whom it gives me great pleasure to dedicate this species.

The single specimen in the collection is of a pink color mottled with creamy yellow, with an obscure yellow line along the jugmu, and with a pale spot on each side of the line on several valves; there are also several irregular dark patches; the posterior valve is deep-rose below the umbo. The girdle is mottled brown and white, there being a white patch at the junction of each valve.

The shell is long, narrow, and arched, anterior and posterior valves with fine concentric ridges; the umbo of the latter is prominent. The intermediate valves are apparently smooth, but really with extremely delicate longitudinal striæ; the lateral areas are characterized by wide ridges. The ligament has stout, tall, imbricate scales.

The three specimens of this species in the British Museum are pink and only slightly flecked with white, no black or brown spots, and in two of them the central areas have concentric lines like those of the lateral areas.

5. *Group of I. punctulatissimus.*

Small species, having the central and lateral areas closely and minutely granulated. No riblets. West Indies and South American coasts.

I. PAPILLOSUS C. B. Adams. Pl. 21, figs. 40, 41.

Shell small, oval, carinated on the back, the side slopes slightly convex; surface not divided into distinct areas, apparently smooth, but under a strong lens seen to be closely and evenly granulated throughout; color whitish, closely mottled with olive-green; or olive-green or olive-brown, with or without snow-white spots.

The lateral areas are not raised, and are sculptured precisely like the central areas, from which they are defined simply by an inconspicuous diagonal ridge. The posterior valve is moderately elevated, the umbo central, rather acute, posterior slope concave.

Interior whitish; anterior valve having 10, central 1, posterior valve 9 slits; teeth sharp, thin and smooth; eaves narrow.

Girdle narrow, alternately olive-brown and whitish, clothed with very minute, imbricating striated scales.

Length 8½, breadth 5 mill.

Length 5½, breadth 3½ mill.

Jamaica (Adams); *Marco, No Name Key and Key West, Florida* (Hemphill).

Chiton papillosus Ad., Proc. Bost. Soc. N. H. 1845, p. 9.—*C. (Ischno.) papillosus* Shuttlw. Bern. Mittheil. 1853, p. 77.—*Isch. papillosus* Dall, Catal. Mar. Moll. S.-E. U. S., in Bull. 37, U. S. Nat. Mus., p. 172.

This is the smallest of our Florida or West Indian Ischnoids. It has much the same sculpture as the small Leptochitons, being uniformly granulated and having the lateral areas very indistinctly defined. It is readily known from other Ischnochitons by these characters. The original description is as follows:

Shell small, wide; greenish, closely maculated with whitish and black; papillose; areas separated by a slender riblet; girdle very finely scaly, alternately greenish and white.

Length 5·25, breadth 3·25 mill.

I. punctulatissimus Sowerby. Pl. 21, figs. 35–38.

Shell oval, moderately elevated, the dorsal ridge bluntly angular, side slopes nearly straight. Surface apparently smooth, but seen under a lens to be minutely and evenly granulated all over. Lateral areas ill-defined. Flesh colored, speckled or dotted all over with light brown, and often maculated on some of the valves or along the dorsal ridge with dark brown.

Lateral areas demarcated by a very low and obtuse ridge, obsoletely sculptured by the intersection of two series of obliquely radiating curved impressed lines; central areas similarly sculptured by obliquely longitudinal lines. Umbo of posterior valve in front of the middle, the posterior slope concave. Interior blue-white, having 9–12 slits in the end valves, 1 in the median valves; teeth acute; eaves moderate; sinus wide, flat. Girdle covered with solid, flattened, striated imbricating scales. Length 17, breadth 10 mill.

Bays of Callao, Mexillones, Iquiqui and Arica, Peru, and Chili, on dead shells, 6–10 fms.

Ch. punctulatissimus SOWB., P. Z. S. 1832, p. 58; Conch. Illustr. f. 9, 26; Moll. Beechey's Voyage p. 149, t. 40, f. 3, 3.—REEVE, Conch. Icon. t. 20, f. 129.

The typical form of this species is described above, and figured on my plate. It is characterized by the almost effaced but even granulation, which is the same on both central and lateral areas, although differing in direction; by the minutely freckled color pattern, etc.

Sowerby mentions a white variety with a black border and somewhat varied with black. This form I have not seen. It has been illustrated by the figures in Captain Beechey's Voyage, H. M. S. 'Blossom,' and fig. 9 of the Conchological Illustrations. The latter figure I have copied on my plate.

I. IMITATOR Smith. Pl. 21, figs. 29–34.

Shell elongate-ovate, moderately elevated, subangularly arched at the middle, dirty white. Valves narrow, with a single notch on each side, exhibiting small, slightly raised lateral areas, which towards the margin have a few transverse strong grooves or marks of growth. Front margin sloping very slightly on each side from the middle in a posterior direction; hind margin straight. Sculpture consisting of close flat granulation, exhibiting a somewhat serial arrangement. Laminæ of insertion [sutural plates] very thin, with a wide sinus between them. Anterior valve sculptured like the others, with fourteen fissures within, the thirteen teeth between them being sharp and straight edged. Posterior valve with a central mucro, from which there is a faint ridge on each side to the lateral extremity, also marked with concentric lines of growth at intervals and with the inner marginal fissures twelve in number. Scales of the mantle minute, imbricating, ovate, arranged lengthwise; under the microscope they appear very coarsely transversely grooved. Length 11 mill.; diam. of fourth valve 5 mill. (*Smith.*)

Tom Bay, Patagonia, on the shore.

Ch. (*Ischnochiton*) *imitator* E. A. SMITH, P. Z. S. 1881, p. 35, t. 4, f. 13.

6. *Group of I. comptus.*

Surface evenly, minutely granulated, the lateral areas having radiating riblets. Girdle scales nearly smooth. Japan, etc.

I. COMPTUS Gould.

Shell small, thin, elliptical; green or scarlet, frequently banded, dotted or maculated with whitish or yellow. Valves short, the end valves radiately ribbed and punctate; central areas quincuncially punctate. Lateral areas elevated and sculptured with 4–5 radiating grooves. Interior green. Girdle narrow, imbricated with small elongated grooved scales. Length 15, diam. 10 mill. (*Gld.*)

Oosima, Japan; Bonin and Liu-Kiu Is. (Stimpson).

C. (*Leptochiton*) *comptus* GOULD, Proc. Bost. Soc. N. H. vii, p. 163; Otia, p. 117.—*Isch. comptus* CPR., *MS.*

Carpenter writes: Entire surface punctate; central areas having the lines of points either parallel or bending toward the acute jugum; lateral areas having small radiating wrinkles, at first 3 to 4 in number, then splitting into 6 to 8. End valves having 40 delicate, hardly apparent radiating wrinkles. Mucro slightly in front of the middle, slightly elevated. Interior: posterior valve with 13, central valve 1, anterior valve 14 slits; teeth acute; eaves moderate, acute; sinus wide, flat. Girdle having large, solid imbricating scales, sometimes very slightly striated. Length 17½, breadth 10 mill.; divergence 120°. Philippines, Mus. Cuming No. 11. Dr. Gould strangely placed this species in Leptochiton, although the scales are as large, solid and regular as in Chiton. The above diagnosis is written from Mr. Cuming's beautiful specimens, which are broad and externally curiously like the young of *Chiton* (*var.*) *patulus:* In the typical specimens, the striulation of the scales can seldom be seen, having apparently lived in exposed situations. The variation in color is extraordinary, being (*a*) densely clouded with olive; (*b*) light ditto mottled with dark and lilac; (*c*) four central valves chestnut, the rest olivaceous; (*d*) brown with olive, with broad white streak down the centre; (*e*) light reddish-chestnut mottled; (*f*) ditto, shading into olivaceous; (*g*) sixth, seventh and part of eighth valve dark olive-brown, the rest light ashy; (*h*) the whole light ash. The sutures are always regularly spotted, as in *T. pseudodentiens.* In the typical specimen examined there were only eleven slits in the terminal valves.

I. LEPIDUS Gould. *Unfigured.*

Shell small, elliptical, roof-shaped, yellow-green streaked with olive; front valve semi-circular, radially striated; posterior valve crescentric, beaked, radially grooved behind and longitudinally in

front; lateral areas elevated, sculptured with 6 radiating sulci; central areas imbricately sulcate. Girdle narrow, banded with olivaceous, covered with minute scales.

Length 13, breadth 9 mill. (*Gld.*)

Interior: terminal valves with about 14, central valves 1 slit; teeth very acute, but a little serrated at the edge. Eaves large; sinus narrow, vaulted, scarcely laminate. Girdle irregularly imbricated with transverse, solid, nearly smooth scales. (*Cpr.*)

China Sea, Lat. 24° *N.*

Chiton (*Lepidopleura*) *lepidus* GLD., Proc. Bost. Soc. N. H. vii, p. 164; Otia, p. 118.—*Ischnochiton lepidus* CPR., *MS.*

The girdle scales are those of Lepidopleurus, [=*Lepidozona*] except that the imbrication is irregular. The species is remarkable for the narrow, arched sinus; and for the slight serration of the insertion plates which are yet normally sharp and protected with broad eaves. I have not been able to re-examine the type since I matured a plan of arrangement for the sections of the genus. (*Cpr.*)

I. PETALOIDES Gould. Pl. 23, figs. 92, 93.

Shell small, delicate, elliptical, roundly arched, very slightly carinated, the valves not beaked, of a pale lemon-yellow ground color, reticulated along the centre, with delicate, angulated, pale-violet lines; these areas are also rugosely lineate-punctate longitudinally, especially toward the margin; lateral areas very prominent, rugosely granulate, and with about four, fine radiating striæ; posterior valve acutely umbonated and crossed by an acute, transverse rib. Margin cream-colored, very finely granulate-imbricate. (*Gld.*)

Interior: posterior valve having 9, central 1, ant. v. 9 slits; teeth acute; eaves acute, hardly spongy; sinus very wide, short, smooth. Girdle imbricated with flat, scarcely striated scales. (*Cpr.*)

Length 12½, breadth 10 mill.

Kauai and Oahu, Sandwich Is.

C. petaloides GLD., Proc. Bost. Soc. N. H. ii, p. 144, July, 1846; U. S. Expl. Exped., Moll. Sh., p. 328, f. 435; Otia Conchol., p. 6; *C.* (*Lucia*) *petaloides* GLD., Otia p. 242.—*Lophyrus petaloides* PSE., Amer. Journ. of Conch. vii, p. 194.—*Ischnochiton petaloides* CPR. *MS.*

The scales are rather large for the size of the shell, but thin. Fresh specimens have sometimes an appearance of minute striula-

tion, from the contraction of the epidermal film. Dr. Gould surmised that this species ought to be a Lucia, because it came from the Pacific Is.; but it is a normal Ischnochiton in all respects except the non-striation of the scales. (*Cpr.*)

I. BISCULPTUS Carpenter, n. sp.

Shell small, oval; jugum acute; mucro median, rather elevated; ashy, maculated with olivaceous. Entire surface minutely granulose; central areas having about 10 distant, acute, subparallel liræ, sometimes subgranose, the interstices wrinkle-decussated. Lateral areas scarcely raised, having distant, small, much raised grains, subradiately arranged in 2–4 series, the end valves having 16–20 such series. Interior: posterior valve having 7, central valves 1, anterior 10 slits; teeth rather obtuse, roughened but scarcely pectinated at the margin. Eaves small; sinus small, deep, smoothly laminate. Girdle rather regularly imbricated with decidedly transverse, conspicuously striated scales. Length 11, breadth 6 mill.; divergence 120°. (*Cpr.*)

? Hong Kong (Stimpson, N. P. E. E.).

"*Chiton ? pulcherrimus* Sby." GOULD, *MS.* + *C.* (*Leptochiton*) *craticulatus* GLD., Otia, p. 117, *pars.* (*Cpr.*).

The shells forming the five species, *pulcherrimus*, *craticulatus*, *cultratus*, *bisculptus* and *asperior* were included by Dr. Gould under the first two names. They need a careful examination of the details of sculpture, as well as of the mantle scales, in order to separate them. Of these *pulcherrimus* and *bisculptus* have the striated scales of *Ischnochiton*; *craticulatus* and *cultratus*, the strong, smooth scales which belong to Lepidopleurus; and *asperior* is intermediate between Trachydermon and Chætopleura. The decided rugosity of the insertion plates and short eaves of this species form a transition toward Chiton. The whole group appears to have a slight lamina at the sinus, marked off by a slit from the sutural wing. (*Cpr.*)

7. *Group of I. interstinctus.*

Small, finely granulated shells, the lateral areas radially ribbed. Scales striated. Species of the west coast of North America.

I. INTERSTINCTUS Gould. Pl. 11, figs. 40, 41; pl. 21, fig. 39.

Shell oval-oblong, rather elevated, the dorsal ridge obtusely keeled, side slopes nearly straight. Surface apparently smooth, but

under a lens it is seen to be very minutely punctulate, the indistinct lateral areas being obsoletely radiately lirate also. Dark reddish, mottled with light on the dorsal ridge.

The lateral areas are scarcely perceptibly raised and besides being microscopically punctulate like the rest of the surface they have low radiating ribs, about 6 or 7 in number. Central areas evenly punctulate; end valves punctulate and radiately multilirate. Umbo of posterior valve in front of the middle, rather elevated. Inside: posterior valve with 12, anterior valve 10, median valves 1 slit; teeth acute, eaves moderate; sinus wide, flat.

Girdle densely covered with small, suboval, delicately striated scales. Length 15, breadth 8 mill.; divergence 110°.

Sitka Harbor south to Monterey and the Santa Barbara Is., California.

Chiton interstinctus GLD., Proc. Bost. Soc. Bost. N. H. ii, p. 145; Moll. U. S. Expl. Exped., p. 315, pl. 23, f. 423; Otia, p. 230, 242. —*Ischnochiton interstinctus* CPR., *MS.* 1891, and DALL, Proc. U. S. Nat. Mus. 1878, p. 331.

This is a small reddish species, characterized by the fine punctation of the whole surface and the rather coarse but low radiating riblets of the lateral areas and end valves. The sculpture is not well shown in Gould's figures. It is drawn from a specimen before me in fig. 39 of pl. 21, representing an enlarged half-valve.

I. NEWCOMBI Carpenter, n. sp. *Unfigured.*

Shell small, wide, tumid, with obtuse rounded jugum. Mucro median, rather elevated. Ashy or olivaceous, elegantly clouded; central areas and entire surface granulated, the granules being quincuncially arranged, close and regular; lateral areas scarcely defined, having about 4 lines of tubercles which are hardly elevated. Posterior valve having about 30, anterior valve 40 such lines. Interior: posterior valve having 12, median 1, anterior valve 11 slits; teeth acute; eaves apparent; sinus wide, short, scarcely laminate. Girdle imbricated with large striated and rather regular scales. Length 8¾, breadth 6¼ mill.; divergence 100°. (*Cpr.*)

Sta. Catalina Is. (Newc.).

The plan of sculpture somewhat resembles that of *I. interstinctus*, though coarser and different in detail. It resembles *I. radians* in most respects except in the rounded beak and larger scales. (*Cpr.*)

I. RADIANS Carpenter, n. sp. *Unfigured.*

Shell rather large, wide, elevated, the jugum acute; olivaceous, elegantly radially streaked with brown. Interior blue-green with two brown rays. Valves delicate, flat, produced in the sinus in front; mucro in front of the middle, scarcely elevated; entire surface quincuncially granulated; lateral areas scarcely defined, and with the end valves obsoletely sublirulate. Interior: posterior valve having 9–10, central valves 1, anterior valve 10–11 slits; teeth acute; eaves small; sinus wide, short, scarcely laminate. Girdle regularly covered with solid, coarsely striated, moderate sized scales. Length 21, breadth 15 mill.; divergence 110°. (*Cpr.*)

Monterey, California.

The internal color-rays are seen in all the dead valves; the external painting resembles *Mopalia vespertina.* The sculpture is on the plan of *I. interstinctus.* One central valve of one specimen, on one side only, had a second slit. (*Cpr.*)

8. *Group of I. scabricostatus.*

I. SCABRICOSTATUS Carpenter. *Unfigured.*

Shell small, orange colored, elevated; valves gothic arched, jugum acute. Entire surface very closely granulated; lateral areas well defined, with 3 subobsolete, radiating series of large granules; beaks scarcely apparent; umbonal margin slightly turned inward, and having dark spots giving a false appearance of teeth. Central areas having separated longitudinal series of narrow, subobsolete riblets, furnished with large granules. End valves having similar radiating granulous riblets. Umbo of posterior valve scarcely central, little projecting. Interior: sutural plates separated by a large flat sinus; insertion plates subobtuse, the end valves having 10–12, central valves 1 slit; eaves moderate, subconspicuous. Girdle wide, closely clothed with imbricating, elongated, transversely striated scales. Length 7½, breadth 4¼ mill.; divergence 100°. (*Cpr.*)

Catalina Island, California, in 10–20 fms.

Lepidopleurus scabricostatus CPR., Rep. Brit. Asso. Adv. Sci. 1863, p. 649; Proc. Cal. Acad. N. S. ii, p. 212.—*Ischnochiton scabricostatus* CPR., *MS.*

The sinus has a thin, smooth lamina separated by a slit on each side from the sutural laminæ. It is a small, arched orange species, with rows of prominent granules over a shagreened surface. (*Cpr.*)

I. VEREDENTIENS Carpenter. *Unfigured.*

Shell small, whitish, tinged with roseate; valves gothic-arched, the jugum subacute; entire surface minutely granulose; lateral areas conspicuously defined, having strong diagonal and sutural ribs, provided with well projecting rounded grains; end valves having subobsolete radiating riblets; central areas having about 8 distant, raised subgranulose longitudinal ribs on each side, the ribs obsolete at the jugum; interstices latticed with subradiating riblets; umbones conspicuous, the umbonal margin deeply toothed by a wart-bearing rib, the teeth 8 to 10, obsolete toward the jugum; margin scarcely intorted. Umbo of posterior valve submedian, slightly projecting; margin elegantly pectinated. Interior: sinus large, flat, sometimes serrate; insertion-plates acute, broadly unifissate, end valves having about 8 slits; eaves conspicuous. Girdle having large flat, striated scales.

Length 6¼, breadth 2½ mill.; divergence 90°. (*Cpr.*)

Catalina Island, 20–30 fms.

Ischnochiton veredentiens CPR., Rep. Brit. Asso. Adv. Sci. 1863, p. 649; Proc. Cal. Acad. Sci. iii, p. 211.

A small arched species, sculptured like *I. mertensii*, but with two rows of bosses, one of which dentates the sutures. The girdle scales are rather large, flattened and striated, as in typical *Ischnochiton*.

I. SERRATUS Carpenter. *Unfigured.*

Shell small, ashy, dotted here and there and especially at the sutures with olive, sometimes spotted with red; oval, subdepressed, the sutures indistinct; entire surface most minutely granulated; lateral areas strongly defined, provided with two to five very wide, obtuse ribs, no interstices; posterior margins elegantly serrated. Central areas having about 12 acute parallel ribs on each side; jugum obtuse, scarcely umbonate; with subradiating latticing ribs, interstices impressed. Mucro median, obtuse. End valves having about 20 obtuse ribs, like the lateral areas. Interior: median valves bifissate, end valves with about 9 slits. Sutural plates large. Girdle imbricated with large, scarcely striated scales.

Length 8½, breadth 5 mill.; divergence 115°. (*Cpr.*)

Cape St. Lucas, Lower California.

Ischnochiton serratus CPR., Ann. & Mag. Nat. Hist. (3) xiii, p. 315, 1864.

I. AUREOTINCTUS Carpenter, n. sp. *Unfigured.*

Shell resembling *I. scabricostatus*, but the lateral areas are scarcely defined, radial and longitudinal series of liræ none. Entire surface equally granulated. Orange spotted with red. Interior: posterior valve having 11, central valve 1, anterior valve 13 slits. Length 6¼, breadth 4 mill.; divergence 100°. (*Cpr.*)

Catalina Island, Cal., 80 fms.

This species is known from *Tr. fluxus* by the valves not being beaked, and by the large striated scales of the margin, which resemble those of *I. scabricostatus.* (*Cpr.*)

I. DECIPIENS Carpenter, n. sp. *Unfigured.*

Shell exactly like *I. pectinulatus*, but reddish, elevated, the jugum acute; scales of the girdle small, striated.

Length 15, breadth 7½ mill.; divergence 105°. (*Cpr.*)

Monterey, California.

This very puzzling shell differs from *I. sinudentatus* in its normal sinus and smaller scales; I cannot help suspecting that when more specimens have been examined, it will be found that some characters generally constant between species and even groups, are occasionally variable in the same species. (*Cpr.*)

I. CORRUGATUS Carpenter, n. sp. *Unfigured.*

Shell similar to *Ch. sanguineus* in form and varied coloring; entire surface granulose; central areas having impressed punctate wrinkles, hardly lirate; lateral areas strongly longitudinally corrugated. Interior: posterior valve with 8–10, anterior valve 10–9, central valves 1 slit. Sinus wide, flat. Girdle thin, covered with very close, very small striatulate imbricating scales.

Length 13¾, breadth 7 mill.; divergence 90°–100°.

Catalina Is., beach to 40 fms. (Cooper, Cal. State Coll. Nos. 1066, 1070, 1074); *Todos Santos Bay* (Hemphill), *California.*

Differs from *Stenoplax sanguineus* in sculpture as well as in the plan of mantle-ornamentation. A specimen from Todos Santos Bay (under a stone between tides) collected by Henry Hemphill, is about the size of *limaciformis* from Mazatlan, and it would naturally be so called; the sculpture, however, is sensibly different, both from that and from *fallax.* The central areas are minutely, the jugal areas very minutely, wrinkle-punctate, wrinkles angular, irregular; lateral areas moderately defined and elevated, and,

together with the end valves, irregularly, subconcentrically and strongly corrugated. Mucro median, planate. This species is a *Stenoplax* in form, but a true *Ischnochiton* in its imbricated scales, which are, however, extremely minute. This specimen is regularly arched, much less elevated than the type, with which, however, it agrees well in particulars. Length 21, breadth 9 mill. (*Cpr.*)

I am unable to see why this should not be considered a *Stenoplax*, unless it be on account of the smaller girdle scales; but, as I have not seen specimens, I deem it best to leave the species where Carpenter placed it.

I. SUBCLATHRATUS Pilsbry. *Unfigured.*

Shell subrotund, depressed (at an angle of 130°); brown-olive; valves very wide, the margins lobed, interstices nearly straight. Intermediate valves granulated at the dorsal ridge and more or less all over, having two strongly tuberculate ribs, one diagonal, the other in front of the suture; lateral areas small, granulate; central areas having four longitudinal bars on each side, the bars tuberculate, interstices granulated. Front valve having about eleven rounded, subtuberculate radiating ribs. Girdle very wide, having close small scales; valve-margins simple, the anterior having 9 slits.

Length 4¼, breadth 3 alt. ·5 mill.

Mazatlan, under stones.

Lepidopleurus clathratus CPR., Mazat. Cat., p. 195 (1857), *Ischnochiton clathratus* CPR., *MS.*—Not *Ch. clathratus* REEVE, Conch. Icon., pl. xviii, f. 113 (1847.)

I have not seen this species, the name of which has been already used by Reeve. Carpenter writes as follows:

One very small specimen was discovered on a stone to which a Crucibulum had been attached, beautifully perfect except in the loss of the anterior valve. A dead anterior valve was found of a much larger specimen displaying a marginal structure like that of *L. sanguineus*. The shell is remarkable for the strong bars across the central areas, and the stout rows of tubercles which run, the one diagonally, the other along the interstitial margin. The mantle is very broad and crowded with minute scales. (*Cpr.*)

I have no opportunity of re-examining the type of this minute shell, to see whether the very minute scales are striated. If so, it must closely resemble the young of *I. expressus*. The paucity of

genuine *Ischnochitons* in the Gulf fauna is remarkable, especially as so many species are found further north. (*Cpr. MS.*)

Section *Lepidozona* Pilsbry, 1892.

Lepidopleurus CARPENTER (Table of Regular Chitons, 1873); DALL, Proc. U. S. Nat. Mus. 1878, p. 331, type *L. mertensii* Midd. —Not *Lepidopleurus* of RISSO, Hist. Nat. Eur. Mérid. iv, p. 267, 1826, nor of H. & A. ADAMS, 1858, nor of CARPENTER, Mazat. Cat. 1857.

Valves having sharp but somewhat rugose and thick insertion teeth, and (typically) the sinus is delicately toothed within. Girdle covered with convex scales, usually smoothish. Type *I. mertensii.*

This section differs from *Ischnochiton* not only in having the girdle scales convex and smooth or but slightly striated, but also in the toothed sinus. It is, however, an artificial group, the species being more closely related to a number of diverse *Ischnochitons* than to each other. Numerous transitions from the smooth convex scales to flat striated scales occur, the variation in degree of striation being considerable in some species. This section in its present limits is therefore merely a temporary expedient for convenience in identifying species. It should rank as a section under *Ischnochiton s. s.*, rather than under *Ischnoradsia*, to which group these species have no especial affinity. The status of the name *Lepidopleurus* has been discussed on page 2 of this volume.

I. MERTENSII Middendorff. Pl. 26, figs. 20–26.

Shell oval, elevated, with angular dorsal ridge, and straight side-slopes. Varying in color from orange-red to claret-red, or even dark red-brown, and either unicolored or speckled and blotched with white.

The lateral areas are elevated, and sculptured with radiating rows of elevated pustules standing upon a smooth, almost flat ground; the pustules of the sutural row often irregular. Central areas having acute, narrow, parallel raised riblets, the intervals between them regularly latticed across, except at the dorsal ridge, where the riblets have a tendency to diverge, and the cross-hatching is obsolete. End valves radially pustulose. Mucro central, low, flat and inconspicuous.

Interior white or blue-white, the median valves when detached showing broad red-brown rays posteriorly, the end valves with cres-

cents of the same color. Sutural plates low; sinus flat, angular, finely toothed. Anterior valve having 10–11, central valves 1, posterior valve 10 slits; teeth rather short and obtuse, and usually distinctly roughened; eaves rather wide.

Girdle firm, compactly covered with regular, solid, oval, shining scales, which are usually smooth, but frequently are superficially or obsoletely striated (figs. 22, 23.)

Length 35, breadth 21 mill.

Length 38, breadth 23 mill.

Sitka south to Monterey, California.

Chiton mertensii Midd., Bull. Acad. Sc. St. Pétersb. vi, p. 118, 1846.—*Chiton* (*Phœnochiton, Hamachiton, Stenosemus*) *mertensii* Midd., Mal. Ross., p. 34, 125, t. 14, f. 1–3, 1847.—*Leptochiton mertensii* H. & A. Ad., Gen. Rec. Moll. i, p. 473, 1854.—*Lepidopleurus mertensii* Cpr., *MS.*, and Dall, Proc. U. S. Nat. Mus. 1878, p. 332.

This species may be known by the more or less red coloring, the shining convex oval scales of the girdle, which are usually almost smooth, and by the strongly developed sculpture. Attention has already been directed to the similarity of the *Chætopleura gemmea* of Cpr. (p. 31), which differs mainly in its sparsely hairy girdle.

Southern examples of this species are larger and more frequently variegated with white than those from the northern part of its range; and the girdle scales seem to be more distinctly striated. They seem to be almost or entirely smooth in most northern specimens, as far as my material shows; and I do not doubt that Carpenter's figure (pl. 26, fig. 23) was drawn from a specimen collected north of San Francisco. In almost all of the specimens from the south which I have examined, the scales show a delicate striation when illuminated from the side, or at right angles to the direction of the striæ. This is shown in figure 22, drawn by the author from a Monterey specimen. The sculpture of the valves is peculiar; the jugal area has diverging liræ, with smooth intervals. This is always most pronounced on the second valve (fig. 24), the other valves often having the liræ more nearly parallel, and the intervals not all smooth. This is shown in fig. 25, representing a fourth valve; but in some specimens the divergence is even less pronounced than in this. The pustules upon the front valve occasionally become soldered together into riblets, but those of the tail valve seem to remain distinct.

I. COOPERI Carpenter, n. sp. Pl. 26, figs. 27–30.

Shell oval and elevated, with angular dorsal ridge and straight side-slopes. Sculpture like *I. mertensii*. Color olivaceous, or dull earthy brown, indistinctly clouded more or less with light blue, especially upon the side areas. The lateral areas are raised, and bear irregular rows of rounded pustules, the young having four rows, the adult 6 to 8. A strong lens reveals a fine, subobsolete granulation of the nearly flat surface between the pustules. The central areas have a fine but distinct and even radial striation, over which run acute narrow raised threads parallel to the dorsal ridge; upon the ridge these threads are seen to be more or less diverging, especially upon the second valve. The end valves are radially ridged, the ridges bearing elongated pustules, or showing scars where such pustules have been. Mucro low, flat.

Interior bluish, the valves marked under their umbones with dark olive. Head valve having 11, central valves 1, tail valve 11 slits; teeth roughened but rather sharp; eaves wide, dark, minutely punctulate, but solid, not spongy.

Girdle compactly covered with small imbricating, deeply striated scales (fig. 28). Length 40, breadth 24 mill.

Santa Cruz and Bolinas, California.

This species closely resembles *I. mertensii* in shape and sculpture, but it differs entirely in the smaller, distinctly striated or grooved scales, in the sombre coloring both outside and within, in the closer pectination of the inter-liral spaces of the central areas, and in the more developed microscopic granulation of the lateral areas. It cannot be claimed that all or any one of these characters is invariable, but the balance of them taken together, seem to indicate that differentiation has proceeded to a stage we may call specific. The following species is allied to this in coloring, but differs sufficiently in sculpture, as well as in the girdle-scales.

The details of sculpture and the scales of all three species are drawn to the same scale. The third valve of *I. cooperi* is shown in figs. 29, 30. It must be remembered that the valves behind this, and usually even the third, have less markedly divergent sculpture than the typical form here shown.

The specimens herein described and figured are from Bolinas, north of San Francisco, and since no diagnosis has been published hitherto, these will be considered the typical specimens. Carpenter's specimens were from Sta. Cruz.

I. SINUDENTATUS Carpenter, n. sp. *Unfigured.*

Shell oval, much elevated, reddish; jugum acute; mucro median, scarcely elevated; entire surface minutely granulose. Central areas having about 12 subparallel bars, which pectinate the front margin, their interstices decussated; lateral areas having 3–4 granose radiating liræ, the anterior valve with 26, posterior valve 24 such liræ. Interior: anterior valve with 10, central 1, posterior valve 9 slits; teeth acute; eaves conspicuous, subspongy, crenulated by the sculpture; sinus wide, short, laminate with about 6 teeth. Girdle having moderate sized, wide, conspicuously striated, rather regularly imbricating scales. Length 15, width 7½ mill.; divergence 100°. (*Cpr.*)

Monterey, California.

This shell has the color of *I. mertensii*, nearly the sculpture of *I. pectinulatus* and the normal scales of this group. Like *I. regularis*, it has the denticulate sinus of *Chiton*. (*Cpr.*)

I. CLATHRATUS Reeve. Pl. 26, figs. 31–34.

Shell oval or oblong, elevated, the back carinated; side slopes straight; lateral areas and end valves radially granulate-lirate, central areas latticed. Color dingy yellow, clouded with black, or rarely unicolored yellow or olivaceous.

The lateral areas are raised and sculptured with about 5 radiating, closely and conspicuously granose riblets, the posterior rib wide or bifid; strongly pectinated along the sutural edge. Central areas having longitudinal narrow bars parallel to the dorsal ridge, decussated by bars of almost equal prominence vertical to them, producing the effect of a grating. Mucro depressed.

Interior whitish, with olive or leaden rays under the umbones. Sinus flat, denticulate; anterior valve having 11–12, central valves 1, posterior valve 14–16 slits; teeth rather sharp, but not thin eaves solid;

Girdle compactly covered with very convex scales, which are quite obsoletely striated.

Length 27, breadth 17 mill.

Length 34, breadth 18 mill.

Monterey and San Diego, California, to La Paz, L. California.

Chiton clathratus REEVE, Conch. Icon., t. 18, f. 113, April, 1847. —*Lepidopleurus pectinatus* CPR., Proc. Califa. Acad. Nat. Sci. iii, p. 211, 1865; not *L. pectinatus* CPR. in Brit. Asso. Rep. 1863, p. 649, (=*I. cooperi* CPR.), nor *Chiton pectinatus* SOWERBY, also an *Ischnochiton* (ant., p. 64).—*Lepidopleurus pectinulatus* CPR. *MS.*, and of American collectors and writers.

Carpenter's diagnosis in Proc. Cal. Acad. Sci. seems to have included both this species and *I. cooperi*, but he afterward distinguished them upon receipt of better material, and re-named the present form "*pectinulatus*."

This species seems to replace *I. mertensii* south of Monterey. It is a dingy, lusterless shell, resembling *mertensii* in the shape of the girdle scales, which are, however, not so bright and clean in the *clathratus*. It has decided riblets on the lateral areas, and the lattice-work of the central areas is strong and much less finely cut than in *cooperi* or *mertensii*. From *I. cooperi*, the different scaling of the girdle, as well as the sculpture of the valves, separate this form.

The second valve has divergent sculpture on the dorsal ridge, but upon the other valves the riblets are parallel or nearly so there, and the interstices are latticed.

I. COREANICUS Adams & Reeve. Pl. 27, fig. 50, (enlarged.)

Shell ovate, rather elevated, terminal valves and lateral areas of the rest radiately grooved, interstices convex, peculiarly grained, grains prominent, round, solitary; posterior terminal valve umbonated, extremity radiate, small, short; central areas longitudinally very finely granosely ridged, interstices between the ridges hollowed; lateral areas blackish-green, grains yellowish, central areas yellowish blotched and variegated with black; ligament finely granosely coriaceous, tessellated dark and pale green.

The sculpture of this species is not much unlike that of *C. luridus*; still it is distinct, and accompanied with a very characteristic style of painting. The central areas of the shell are of a yellowish ground, blotched and variegated with black. The terminal and lateral areas are very dark green, with the prominent granules conspicuously tinged here and there with yellow. The ligament is strikingly tessellated with dark and pale sea-green. (*Rve.*)

Korean Archipelago, under stones (Belcher.)

REESE LIBRARY OF THE UNIVERSITY OF CALIFORNIA.

Chiton coreanicus REEVE, P. Z. S. 1847, p. 24; Conch. Icon., t. 26, f. 128.—ADAMS & RVE., Voy. 'Samarang' Zool., Moll., t. 15, f. 9.—SCHRENCK, Reis. u. Forsch. im Amur-Lande, ii, p. 281, f. 1–6. —*Lophyrus coreanicus* DKR., Ind. Moll. Mar. Jap., p. 157.

Carpenter (*MS.*) compares this to *I. pectinulatus* and *I. cooperi.* Schrenck reports it from the Bay of Hakodadi, on the authority of Lindholm.

I. PULCHERRIMUS Sowerby. Pl. 27, figs. 47, 48.

Shell oval, elevated; jugum acute; mucro conspicuous, elevated, median, the slope behind it concave. Color red, variously clouded or streaked with ashy. Jugal area hardly defined, smooth at the prominent beaks; central areas having 16 to 18 acute, subparallel liræ on each side, meeting over the jugum but otherwise nearly parallel; interstices crenulated; entire surface granulated. The interstices are decussated by the buttresses, as it were, of the crenulated sides. Lateral areas with 3 principal rows of close knobs, increasing to 5 rows by intercalation. End valves having 16 to 20 such rows, the interstices crenulated. Sutures with sharp rows of granules in addition to the contiguous ribs. Interior: anterior valve with 7, central 1, posterior valve 10 slits; teeth obtuse, striated, slightly pectinated; eaves small; sinus deep, flat, denticulate. Girdle tessellated, imbricated with large, solid, more or less striated rounded scales. Divergence 97°–107.° (*Cpr.*)

Length 24, breadth 13 mill.

Island of Bohol, Philippines.

Chiton pulcherrimus SOWB., P. Z. S. 1841, p. 103.—REEVE, Conch. Icon., t. 20, f. 132.

This species, says Carpenter, is very close to *I. mertensii.* The striation of the scales is conspicuous in some specimens, on others scarcely seen, yet they all appear conspecific. The species is exactly intermediate between the two genera, *Chiton* and *Ischnochiton*, the teeth being scarcely pectinate enough for *Chiton*, and yet it has the balance of its characters. One specimen has very little light, clouded with dark; one almost entirely light, with one dark streak on both sides of the central areas; other specimens are intermediate. (*Cpr.*)

I. CRATICULATUS Gould. *Unfigured.*

Mucro central, scarcely elevated; central areas having 18–22 bars; on the acute, much elevated jugum scarcely obsolete;

interstices transversely wrinkled. Lateral areas having close, little elevated graniferous riblets, 4 in young, 8 to 10 in adult individuals; anterior valve having about 50 such riblets. Interior: posterior valve having 11, central valves 1, anterior valve 10 slits; teeth short, not very acute, outside and at the margins in front rugulose, almost pectinated in front. Eaves small, obtuse; sinus short, narrow, slightly denticulate. Girdle irregularly, closely imbricated with small, smooth, solid scales.

Length 25, breadth 15 mill.; divergence 93°. (*Cpr.*)

China Seas, or Japan (Stimpson, N. P. E. E.; 1 specimen in Mus. Smithsonian.)

Chiton (*Leptochiton*) *craticulatus* GOULD, Proc. Bost. Soc. N. H. vii, p. 161, Dec. 1859; Otia Conch., p. 117.—*Lepidopleurus craticulatus* CPR., *MS.*

Dr. Gould appears from his diagnosis to have had several species under his eye when he wrote the description of this species. From his calling it a *Leptochiton*, he might have looked at the minute, chaffy scales of *Trachydermon asperior;* when he wrote of long striated scales, he was probably observing *Ischnochiton bisculptus.* Again when he noted the great variation of the ridges (from 4 to 8), he probably had under his eye both *I. cultratus* and the species above described. Of the four, the balance of characters inclines me to retain the name for the shell last mentioned, although only one specimen was returned of it, mixed with the other three. Outside, the species is recognized by the solid smooth scales, and details of sculpture; inside by the blunt, somewhat rugulose teeth, which (in part of the anterior valve) are almost pectinate. (*Cpr.*)

I. CULTRATUS Carpenter, n. sp. *Unfigured.*

Shell similar to "*L. craticulatus*"; mucro central, planate, but central areas having about 14 to 20 very acute, strongly developed subparallel liræ, becoming less acute, somewhat obsolete, on the dorsal ridge; sutures elegantly pectinated, interstices cancellated with small wrinkles; lateral areas having 4 low, graniferous lirulæ, and a fifth line of granules at the sutures, the grains sparse, small, but strongly projecting. Posterior valve having about 18 similar lirulæ, anterior valve 24. Interior: posterior valve having 9, central valves 1, anterior valve 8 slits; teeth acute; eaves projecting; sinus small, deep, sensibly laminated, smooth. Girdle regularly imbricated with flat, smooth scales. (*Cpr.*)

Length 27, breadth 17 mill.

Hakodadi, Japan (Stimpson, N. P. E. E. Smithsonian Mus., No. 1672.)

Chiton pulcherrimus (*pars*) GLD., *MS.*, not SOWB.—*Leptochiton craticulatus* GLD., *pars*, Otia, p. 117. (*Cpr.*)

This species differs from *I. pulcherrimus* Sowerby in having five rows of extremely fine, distant, but strongly expressed granules, instead of three (rarely four) of very coarse ones. This has the space between the very sharp, knife-like central ridges but faintly cancellated with rugose lines; while in pulcherrimus the cancellation is so strong as to make the ridges appear granular. But the principal distinction is that pulcherrimus has strong striæ on the mantle-scales, while those of cultratus are smooth and larger in proportion. It has the same general aspect as *I. craticulatus;* but differs in having the central ridges further apart and sharper; the side rows of points scarcely half as numerous, and the scales much larger and more regular. (*Cpr., MS.*)

I. MUSCARIUS Reeve. Pl. 24, figs. 9, 10.

Shell oval, jugum rather sharp, mucro at the anterior third, rather raised, the slope behind it very concave. Color a peculiar ash, with irregular brown spots over the central areas, and brown crescentic lines over the lateral areas; and valves with spots of dark shaded with light. The central areas have a conspicuous quincuncial granulation. Lateral areas somewhat raised, with about 7 very indistinct small riblets, also quincuncially granulated, and having an appearance of being concentrically sculptured, caused by the color-markings. Interior: posterior valve having 12, central 1, anterior valve 12 slits; teeth very sharp; eaves moderate, not spongy. Girdle covered with imbricated, smooth, moderately large, stout oval scales.

Length 18½, breadth 11, divergence 119°. (*Cpr.* from type in B. M.)

Mazatlan.

Chiton muscarius REEVE, Conch. Icon., t. 24, f. 164.—*Lepidopleurus muscarius* CPR., *MS.*, p. 120.—*Lepidopleurus? macandrei* CPR., Mazat. Catal., p. 196.—*Ischnochiton macandreæ* CPR., *MS.*, p. 88.

Carpenter seems to have decided that the *L. macandrei* of his Mazatlan Catalogue was identical with Reeve's *C. muscarius*, although he remarks that he would not have known it from the

figure and description given by Reeve.

I. PUSIO Sowerby.

Shell oval, smooth; olivaceous, ornamented with numerous green dots; front and side margins of the valves rugulose. Marginal ligament scaly. Length 12½, breadth 7½ mill. (*Sowb.*)

Valparaiso, on Amphidesma solidum, 30–50 fms.; sand bottom.

Chiton pusio SOWERBY, P. Z. S. 1832, p. 105.

I. DALLII Haddon. Pl. 25, fig. 1–10.

Shell evenly covered with closely set minute low tubercles, which give it a granular appearance; with straight-sides meeting at an angle of 110°. Anterior valve closely granular, with twenty-six short radial rows of tubercles, each row consisting of four or five tubercles, which diminish in size from the periphery towards the apex; the posterior row is the broadest, and is partially bifid.

Intermediate valves. Central area: jugum coarsely granular; pleura with about 12 or 13 distinct horizontal ridges; lateral areas granular, with three main radiating rows of tubercles, the anterior and posterior often partially double. Posterior valve remarkably flat, coarsely granular, with nineteen rows of three tubercles each, of which the outermost is the largest; umbo scarcely, if at all, raised above the surface; anterior border coarsely granular, with the granules passing into oblique ridges on the pleura.

Girdle medium breadth, upper surface with smooth imbricating scales in oblique rows, about seven or eight in a row, those nearest the shell being the smallest. Color greyish-white.

Length 11, breadth 6, height about 3 mill.

Gills extending to about three-quarters the length of the foot, diverging posteriorly and hidden by a slight swelling of the longitudinal band on the under surface of the girdle; about twenty-one in number, largest about the fifth from the posterior end, and gradually diminishing in size anteriorly. (*Haddon.*)

Lat. 51° 27′ 30″ S., long. 74° 3′ W., 400 fms. blue mud.

Lepidopleurus dallii HADDON, Challenger Polyplac., p. 19, t. 1, f. 6, t. 3, f. 6*a*–6*i*.

I have associated this species with the name of my friend Mr. W. H. Dall, of the Smithsonian Institution, Washington, U. S. A. (*Haddon.*)

I. NEBULOSUS Carpenter, n. sp. *Unfigured.*

Shell oval, little elevated, the jugum acute; mucro slightly elevated; brown-olive, elegantly dotted and clouded with darker, and sometimes maculated with ashy or roseate. Central areas granulated in a somewhat quincuncial manner, rather regular lines radiating from the jugum. Lateral areas scarcely elevated, having 3 to 5 scarcely projecting radiating wrinkles; end valves having 30 to 40 subobsolete radiating wrinkles, and granulated like the central areas. Interior: posterior valve having 11, central valves 1, anterior valve 11 slits; teeth acute; eaves large; sinus moderate, flat, smooth. Girdle variegated, regularly covered with solid, large, subrotund smooth scales.

Length 15, breadth 10 mill.; divergence 110°. (*Cpr.*)

St. Vincent, Cape Verde Is.

Curiously like *I. comptus* in color and sculpture, but that species has the scales extremely finely striated, the side areas a little more decided, the granulation less regular, the painting more sombre and the sutures tessellated. These minute differences, joined with the wide separation in locality, probably denote a different origin. (*Cpr.*)

The type is no. 88 of the Cumingian collection.

I. OBTUSUS Carpenter, n. sp. *Unfigured.*

Shell small, strongly elevated, oval, the jugum little acute; mucro median, conspicuous. Reddish-brown, variously maculated with paler. Central areas having about 10 subparallel deep sulci on each side, obsolete upon the jugum; lateral areas with 3 to 4 radiating wrinkles, sometimes divaricating, the end valves having 20 to 40, here and there interrupted by wrinkles of growth. Interior: posterior valve having 8, central valves 1, anterior valve 9 slits; slits small, teeth very short and obtuse, sometimes rugulose or almost pectinated; calloused inside; eaves small; sinus moderate, excurved, smooth. Girdle furnished with very close, small, very solid, rounded, smooth scales.

Length 12½, width 7½ mill.; divergence 85°. (*Cpr.*)

Portugal (Mus. Cum., no. 105.)

A remarkable shell, presenting some general resemblance to *mertensii* in the appearance of the valves. The girdle scales are as small as in *Trachydermon*, but very solid. The specimen is much worn outside, which may account for the bluntness and callosity of the teeth. (*Cpr.*)

I. LENTIGINOSUS Sowerby. Pl. 27, fig. 44.

Shell oval, carinated, smooth; back elevated; lateral areas inconspicuous. Color tawny brown, ornamented with rounded blue spots. Margin minutely scaly. Length 15, breadth 9 mill. (*Sowb.*)

"*Newcastle, Australia.*"

C. lentiginosus SOWB., The Magazine of Natural History, conducted by Edw. Charlesworth, iv, new series, p. 293, June, 1840; Conch. Illustr., f. 120.

Chiton cyaneopunctatus KRAUSS, Die Südafric. Moll., p. 40.

Except in being somewhat larger, and said to be from a different locality, this seems to be absolutely the same as *I. cyaneopunctatus* Krauss. It is likely that the Australian habitat assigned to *lentiginosus* is a mistake. The description of *cyaneopunctatus* here follows:

C. cyaneopunctatus Krauss. (Pl. 27, figs. 40–43). Shell small, oblong-ovate, thin, semi-pellucid, convex, carinated, shining, ashy, orange or brown, closely painted with dots and lines of blue; very minutely punctulate; intermediate valves narrow, subrectangular; lateral areas slightly distinct; end valves delicately concentrically striolate. Girdle ashy and rufous banded, scaly, the scales distinct, subrotund, polished, shining.

Length 10½, breadth 6 mill. (*Kr.*)

Cape of Good Hope.

The valves appear smooth to the naked eye, but under the lens delicate, elevated points are visible upon the central areas; and on the slightly raised lateral areas and the end valves, there are very delicate concentric striæ. The head valve has 12, the posterior valve 13 slits. The median valves are very narrow (5·2 mill. wide, 1·2 long), with one slit in the insertion-plates. The scales of the girdle are as large as those of *C. capensis* Gray, shining, convex and rounded. The color is very various: gray, blue-gray, yellowish and reddish-yellow to brown shells occurring, but all show under a lens sky-blue dots, which frequently coalesce into lines. The girdle has darker transverse bands. (*Krauss.*)

I. DORSUOSUS Haddon. Pl. 25, figs. 11–19.

Shell remarkably compressed laterally, the two sides meeting at an angle of 75°. Anterior valve concentrically rugose, with about 26 radiating low irregular ridges, some of which bifurcate. Central areas, with jugum and anterior border striated, the pleura with distinct horizontal ridges. Lateral areas distinct, concentrically rugose,

usually with three main radiating low ridges, the anterior and posterior of which are often bifid. Posterior valve concentrically rugose, with fifteen irregularly arranged low radiating ridges. The anterior ridge is broader than the others, and may be slightly bifid, umbo rudimentary; anterior border smooth, with slight concentric lines of growth. Laminæ of insertion moderate in size.

Girdle narrow. Upper surface with ovoid, slightly overlapping, somewhat granular scales; edge with minute projecting spicules; under surface, with long, narrow, closely applied scales. Color white.

Length 21·5, breadth 7·5, height 6 mill. (*Haddon.*)

Prince Edward's Island, Lat. 46° 41′ S., long. 38° 10′ W. 310 fms.

Lepidopleurus dorsuosus HADDON, Challenger Polyplac., p. 18, t. 1, f. 5; t. 3, f. 5*a*–5*i*. 1886.

Gills extending to more than half the length of the foot, twenty in number, the middle somewhat larger than the remainder. The name *dorsuosus*, full of ridges, is applicable to this species on account of its numerous longitudinal and radiating ridges, and at the same time recalling the steep ridge of the shell itself. (*Haddon.*)

I. ADELAIDENSIS Reeve. Pl. 24, figs. 7, 8 (enlarged.)

Shell somewhat shortly ovate, very minutely reticulated throughout, under the lens; terminal valves and lateral areas of the rest finely ridged, ridges waved, central areas smooth, lateral areas not raised; livid olive and yellow, flamed with brown in the middle, posterior edges of the valves articulated with brown; ligament granately coriaceous, grains very large. (*Rve.*)

Port Adelaide (Rve.); *Port Molle, Queensland* (Coppinger), *Australia.*

Chiton adelaidensis REEVE, Conch. Icon., t. 19, f. 123.—*C.* (*Ischnochiton?*) *adelaidensis* E. A. SMITH, Zool. H. M. S. 'Alert,' p. 79, 1884.—*Lepidopleurus adelaidensis* CPR., *MS.*

Smith gives the following notes on the specimens collected at Port Molle by Coppinger:

The entire surface of this species is minutely granosely reticulated, the front valve, the lateral areas of the narrow central valves, and the hinder area of the posterior are in addition somewhat irregularly radiately sulcate. The prevailing color is pale greenish, streaked and dotted with red, the posterior margin of the valves being paler

than the general tone of the shell, and conspicuously spotted with the same red color. The grains of the mantle are smooth, arranged in alternate greenish and reddish patches, and individually have a dark spot generally on the outer side, which is only seen under a lens; those near the valves are considerably smaller than those situated toward the edge of the girdle. Having parted the valves of one of the specimens I find the front one has the margin of insertion divided into seventeen unequal, squarely cut, slightly crinkled, sharp-edged teeth, of which the two outer on each side are the largest. The sixteen slits between the teeth are very small and shallow. The second, third, fourth, fifth, and sixth valves have on each side a single very small narrow central notch, from which a groove or depression runs to the apex of each valve; the seventh is probably abnormal, having a single notch on the right side and two on the left, and the terminal valve has nineteen similar slits.

I. milleri (Gray) Reeve. (Pl. 24, figs. 18, 19). Shell ovate, smooth; central areas under the lens most minutely reticulated; lateral areas very finely striated. Olive or sometimes white, blotched and dotted with black. Ligament coriaceous, tessellated with black and yellow. (*Rve.*)

"*Eastern Seas.*"

Chiton milleri ("Gray,") Reeve, Conch. Icon., t. 23, f. 156*a*; t. 24, f. 156*b*, *c*.

This species was not described by Gray, although Reeve refers to the Spicilegia Zoologia. It has been stated by d'Orbigny to be a synonym of *punctulatissimus*. Carpenter seems to think it the same as *adelaidensis*. The types should be re-examined in order to settle the point.

I. smaragdinus Angas. Pl. 60, fig. 20.

Shell oblong-elliptic, elevated, most minutely punctured, dull bluish-green, delicately freckled with olive, the hinder edges of the valves ornamented with very small white spots bordered with olive; the terminal valves and lateral areas faintly concentrically striated, the central valves carinated, with the dorsal areas faintly transversely striated, the lateral areas slightly elevated; the mantle-margin pale green marbled with black, and covered with small smooth imbricated scales. Length 12 mill. (*Angas.*)

Lilac, variegated with bluish, the side areas distinct, slightly raised, more variegated and darker than the central areas. Jugum

sharp; mucro not much raised, situated at the front fourth, posterior slope a little concave. Valves square, not beaked; glossy, with very fine quincuncial granulation. Inside: posterior valves having 10 or 11, central valves 1, anterior valves 11 slits; teeth sharp, thin, and rather long; sinus broad, deep, flat, not channelled at the sides; eaves projecting, granulated in quincunx but not spongy. Girdle with rather large, stout, smooth roundish scales. (*Cpr.*, from types). Length 13½, breadth 8 mill.; divergence 120°.

Port Jackson, New South Wales, Australia.

Lophyrus smaragdinus Angas, P. Z. S. 1867, p. 115, t. 13, f. 28; *t. c.*, p. 222.—*Lepidopleurus smaragdinus* Cpr., *MS.*

I. sulcatus Quoy & Gaimard. Pl. 38, figs. 24, 25, 26.

Shell oval-oblong, quite convex, obtusely triangular, with narrow girdle ornamented with little, rounded scales, each of which is greenish with a brown dot. The valves are wide, arcuate, almost without carina, very prettily grooved lengthwise on the sides, and zigzag in the middle. The lateral areas are triangular, granulose, and elevated. The anterior valve is simply granulated, with 11 or 12 teeth; the posterior valve is larger with 13 teeth, and above it is striated in front, and with marginal granulations. The sutural-plates are short and separated. All of these parts are of a handsome clear green varied with white. The base of each of the lateral triangles is white. Each valve has at the summit a green spot surrounded with whitish, or sometimes with rose, in which case the interior also is roseate. Length 30, width 18 mill.

Port of King George, S. Australia.

C. sulcatus Q. & G. Voy. Astrol. iii, p. 385, t. 75, f. 31–36.—(Not *Chiton* (*Radsia*) *sulcatus* Wood.)

The generic position of this species cannot be known until the characters of the insertion-plates are more exactly described. The above description is from Quoy, who remarks that the species has considerable resemblance to *C. viridis* Q. & G. (*C. quoyi* Dh.), differing in the sculpturing of the valves, especially the end valves.

I. tessellatus Quoy & Gaimard. Pl. 24, figs. 13, 14, 15.

A small oval species, nearly flat, having a rounded carina. Grayish all over, but under a lens showing white and brown elongated spots. The valves are very finely granulous, the lateral areas sulcated radially. The two end valves have smooth teeth, 12 in the head valve, and more on the last valve. The girdle is scaly,

yellowish or greenish, and regularly spotted with brown. The foot is narrow, yellowish; the gills almost reach the head.

Length 18, breadth 12, alt. 4 mill.

Port Carteret, New Ireland.

Chiton tessellatus Q. & G., Voy. de l'Astrol., Zool. iii, p. 396; atlas, t. 75, f. 43–47.

The description is from that of Quoy and Gaimard. The coloring is probably less vivid than shown in their plate. The artist of the 'Astrolabe' seems to have had an irrepressible fondness for green.

I. ARBUTUM Reeve. Pl. 24, figs. 16, 17.

Shell ovate, terminal valves and lateral areas of the rest reticulately decussated with grained striæ diverging off posteriorly; central areas very closely sculptured with blunt squarish granules; green or reddish, dotted with black; ligament squamately coriaceous, tessellated. (*Rve.*)

Port Essington.

C. arbutum Rv., Conch. Icon., t. 24, f. 162.

Carpenter thinks this is probably a color variety of *I. adelaidensis.* He gives the following notes on the 8 specimens in the Cuming collection: Shell ovate, tolerably elevated, rather broad; jugum more or less obtuse. Reddish orange, olivaceous or light ash, more or less spotted and clouded, but always with a very fine tessellation of dark and light along the sutures. Mucro in front of the middle, the slope behind it concave; intermediate valves oblong, not beaked; central areas coarsely and *very regularly* quincuncially granulated with large grains; lateral areas very slightly raised, with about 6 rows of larger grains. End valves with similar grains, which are radiating but scarcely in lines. Interior: anterior valve having 11, central valves 1, posterior valve 16 slits: teeth quite sharp, typically Ischnoid; eaves large, not spongy. Girdle tessellated with olive and light, covered with imbricating short roundish and quite smooth scales. Length 12½, breadth 8 mill.

Section *Radsiella* Pilsbry, 1892.

Radsiella PILS., Manual of Conch. (I) xiv, p. 54 (July 25, 1892). Type, *I. tridentatus* Pils.—*Ischnoradsia* CARPENTER *MS.* and DALL, Proc. U. S. Nat. Mus. 1878, p. 331. Not *Ischnoradsia* SHUTTLW., 1853.

Valves and girdle entirely similar to those of the normal *Ischno-*

chitons, but insertion-plates of the intermediate valves having two or several slits.

The present section differs from *Ischnoradsia* Shuttleworth (*Lepidoradsia* Cpr.), in having the girdle covered with flat, striated scales, whilst in the latter group the scales are transformed into smooth, solid, pebble-like bodies. *Radsiella* differs from the Radsioid section *Stenoradsia* in having the short contour and anterior mucro of the true Ischnochitons, and in the normal foot and gills.

Carpenter's use of the name *Ischnoradsia* Shuttlw. for this group is clearly indefensible, as Shuttleworth mentions none of the species now included herein, whilst his diagnosis covers all Radsioid forms of *Ischnochiton*. I have therefore restricted the name *Ischnoradsia* to the forms grouping around Shuttleworth's first species, *australis*.

I. TRIDENTATUS Pilsbry, n. sp. Pl. 18, figs. 35, 36, 37, 38, 39.

Shell small, oval, moderately arched, slate-color with white spots and dots, or white mottled with slate; the girdle tessellated with alternate dark and light, the interior blue, with a leaden spot under each sutural-plate, and short dark rays from the apex.

The valves are evenly arched. The posterior valve (fig. 39) has a central, rather depressed umbo, the slope behind it concave. Lateral areas raised a trifle, but scarcely distinguishable; central areas evenly, closely and finely pitted in quincuncial pattern; the lateral areas are a little more coarsely sculptured with close low diamond-shaped granules; the granulation generally less regularly arranged on the end valves than on the lateral areas.

Interior with low, arched sutural-plates and wide, flat, angular sinus; anterior valve with 13, posterior 12, central valves 2 slits. Teeth sharp, smooth. Eaves very narrow.

Girdle covered with imbricating striated scales (fig. 36.)

Length 15, breadth 10 mill.

La Paz, Lower California (Lockington); *Gulf of California* (Gabb.)

?? *Ischnoradsia dispar* CARPENTER, *MS.* not SOWERBY.

This species is easily separated from *I. dispar* Sowb. by the apparently *similar* sculpture of central and lateral areas, the sculpture in *dispar* being obviously diverse on these areas. I suppose this to be what Carpenter considered *dispar* merely because it has Radsioid valves; but Carpenter has given no description of his shells.

The foot is not produced forward beneath the head, as it is in *Stenoradsia*. The gills extend from the front end of the foot to within somewhat less than the width of a valve from the tail end.

I. VIRIDULUS Couthouy. Pl. 17, figs. 32, 33.

Shell small, oblong, rather elevated and decidedly carinated; creamy yellow, or "of a very pale olive or drab color." Surface smooth to the naked eye, but under a lens it is seen to be everywhere covered with low granules quincuncially arranged. The lateral areas are a trifle raised, but not distinctly so, and upon them the granulation is somewhat effaced, and a few *very obsolete* radiating sulci are generally distinguishable, as well as several rather strongly indicated growth-periods. "Interior: posterior valve having 13–14, (rarely 17), anterior valve 14–16, central valves 2–3 slits. Teeth acute, distant; eaves acute, projecting, hardly spongy; sinus wide, short, flat. Girdle covered with rather large, wide scales, deeply and distantly striated." Length 13, breadth 7 mill.

Orange Harbor, Terra del Fuego.

Ch. viridulus COUTH. *MS.*, GOULD, Proc. Bost. Soc. N. H. ii, p. 144, 1846; Otia Conch., p. 5; U. S. Expl. Exped., Moll., p. 318; atlas, f. 413.—*Ischnoradsia viridulas* CPR., *MS.*—*Lepidopleurus viridulus* ROCHEBR., Miss. Cape Horn, Polyplacophores, p. 140.—? *Ischnochiton viridulus* Gld., HADDON, Challenger Rep., p. 16, 1886.

A small form, evenly granulated, and having indistinct lateral areas. I have taken the description of the internal parts from Carpenter's *MS.*, as I have not examined the interior of the single specimen before me, which is one of the original lot.

I. TRIFIDUS Carpenter. Pl. 18, fig. 40.

Shell rather large, rather elevated, regularly oval; red-chestnut, maculated with lighter and darker; jugum acute, gothic. Mucro median, flat; entire surface very minutely granulated; central areas having about 8 strongly punctate lines perpendicular to the jugum; lateral areas strongly defined, having 2 to 4 obsolete ribs, sometimes punctate in the interstices.

Interior whitish flesh-colored, with two reddish-purple rays diverging from the flat umbones; posterior valve having 13, anterior 13, central valves 2 slits; teeth acute, sometimes serrated at the edge, sometimes striated outside, sometimes smooth. Eaves subspongy; sinus small, laminate, the lamina slit at the sides and sometimes in

the middle. Girdle having very small, solid, smooth scales. Gills almost ambient. (*Cpr.*)

Length 40, breadth 26 mill.; divergence 135°.

Sitka to Puget Sound, 9–18 fms.

Trachydermon trifidus CPR., Suppl. Rep. B. A. 1863, p. 649; Proc. Acad. Nat. Sci. Phila. 1865, p. 60.—*Ischnoradsia trifida* CPR., *MS.*, and DALL, Proc. U. S. Nat. Mus. 1878, p. 331.

I have not seen this species. The figure is from a rude sketch in Carpenter's *MS.* Dr. Dall writes of it as follows:

This rare and fine species is not particularly handsome, being of dull and livid colors, but is peculiarly characterized by the straight transverse ribs on the dorsal areas with spongy interspaces, and by the pretty regular division of the lateral areas into three well marked radiating costæ, which are separated in the insertion plate by two fissures. No other species of the region resembles this in sculpture. Muzzle with a pectinated margin in front produced into rounded lappets at the corners. Gill rows as long as the foot, containing each 28–35 branchiæ. Veil absent. Mantle edge plain, narrow. There is a small spherical lump on each side of the girdle just behind the posterior ends of the gill-rows, which are turned out toward the girdle and widely separated behind. The anus is large median, and crenate, opening on the upper part of the hinder end of the foot. No ovarian openings could be detected, and the species presents some peculiarities which call for further research with more material. (*Dall.*)

I. REGULARIS Carpenter. Pl. 18, figs. 41–46.

Shell oblong, elevated, dorsally carinated, the side-slopes straight. Surface appearing almost smooth to the naked eye. Color a uniform olive or slaty-blue, the girdle having more or less of a blue or purple "bloom."

The lateral areas are very little raised, and are sculptured with numerous delicate radiating threads, occasionally branching toward the lower margin, and freely branching along the posterior edge of the valve. The terminal valves have similar delicate radii. The central areas have numerous longitudinal, somewhat beaded threads, separated by flat intervals. The posterior valve is elevated, with anterior umbo.

The interior is light blue. Sutural plates low, connected across the sinus by a narrow plate which is sulcate above and cut into

about 10 teeth by delicate slits. Anterior valve having 14–16, central 2–3, posterior 22 slits. Teeth even and sharp, slightly striated or grooved outside. Eaves solid. Girdle wide, flat, covered with solid, regularly and closely imbricating striated scales (fig. 46). Length 35, breadth, 19 mill.

Monterey, California.

Chiton regularis CPR., P. Z. S. 1855, p. 232.—*Ischnoradsia regularis* CPR., *MS.*

This species is of a very regular form, and a uniform drab, olive or blue color. It is not closely allied to any other West Coast form. The number of slits in the posterior valve is unusually large.

I. TIGRINUS Krauss. Pl. 19, figs. 60–63.

Shell oblong, convex, roundly arched, buff-white, unicolored, or striped lengthwise with reddish; rarely roseate.

Valves without apices. The lateral areas do not extend to the middle of the back; they are raised, and cut into radiating riblets by 8 or 10 narrow impressed grooves, and there are rather conspicuous concentric wrinkles or waves of growth on the lower part of the areas. The end valves are similarly sculptured. Central areas closely and regularly pitted all over. Posterior valve rather large and depressed, with subcentral umbo.

Interior white and light brown. Anterior valve having 17–18, central valves 2–3, posterior valve 12–13 slits; teeth rather thin, but somewhat bevelled and roughened inside; eaves solid. Sinus wide and flat, the sutural-plates being rounded. Muscle-scars distinctly impressed.

Girdle rather wide, firm, densely clothed with somewhat convex, finely striated scales (fig. 63). Length 22–28 mill.

Cape of Good Hope.

Chiton tigrinus KRAUSS, Die Südafric. Moll., p. 38, t. 3, f. 5.—? *Ischnoradsia subcariosa* CPR., *MS.*

This species is readily known by its Radsioid valves and the beautiful web-like sculpture of the central areas, produced by the pattern of regularly arranged rhombic pits. It is like no other species, although the young of *I. magdalenensis* bears a slight resemblance in the sculpturing of the central areas.

Although technically a *Radsiella* or *Stenoradsia* (it is not easy to decide which) this species probably was developed from a different stock of Ischnochitons. Indeed, the multiplication of side-slits may

be expected to occur in any branch of Chitons; from the genus *Ischnochiton* alone, we have at least four or five independent Radsioid branches.

The typical *I. tigrinus* of Krauss is striped longitudinally. The unstriped form, of which several specimens are before me, may be called var. *unicolor*.

The species mentioned by Carpenter as *I. subcariosa* may be a form of *I. tigrinus*. The type is a single specimen of unknown origin, and is in the museum of McGill College, Montreal.

Subgenus VII. Ischnoradsia Shuttleworth, 1853.

Ischnoradsia Shuttlw., Berner Mittheil. 1853, p. 65, species cited *C. australis* and *C. magdalenensis*. Not *Ischnoradsia* Cpr.—*Lepidoradsia* Carpenter, *MS.*; and Dall, Proc. U. S. Nat. Mus. 1878, p. 331, type *C. australis*.

Valves having sharp but rather thick insertion plates, those of the median valves with two or several slits. Girdle covered with convex, pebble-like, smooth scales. Type *Chiton australis* Sowb.

The typical forms of this section are from the Australian seas, but several species have also been found in Japanese waters.

Carpenter's substitution of the name '*Lepidoradsia*' in place of *Ischnoradsia*, was in direct violation of the rules of nomenclature.

Key to species.

a. Sinus dentate within, *albrechti*.

aa. Sinus smooth.

b. Central areas longitudinally ribbed, *australis, lugubris*.

bb. Central areas minutely granulated.

c. Outside green, inside green and pink; scales very convex, *novæhollandiæ*.

cc. No green or pink; scales small, convex, *hakodadensis*.

I. australis Sowerby. Pl. 18, figs. 57, 58, 59.

Shell oval-oblong, moderately elevated, the dorsal ridge subangular, side-slopes nearly straight. Color dark olive-brown, the apices of the valves pink when eroded.

Lateral areas somewhat raised and sculptured with close, uneven riblets, which usually bifurcate or branch freely, especially toward the posterior margin of the area. *Central areas closely and evenly*

sculptured with finer longitudinal riblets, obsolete on the ridge, where they give place to a dense microscopic granulation. The worn apices of the valves are pink in mature shells. End valves sculptured with close radiating riblets, those of the posterior valve irregularly granose; mucro rather depressed; posterior slopes of the tail valve depressed and concave.

Interior light blue-green, with two wide pink rays in each valve, and behind them two olive-brown rays. Sutural plates rounded, whitish or yellowish; sinus wide, flat, not in the least toothed. Insertion plates having 16–21 slits in the anterior, 2 or 3 in the median, and 17–21 in the posterior valve; teeth rather thick and stumpy, and a little rugose, but sharp edged. Eaves wide and solid. Girdle (fig. 57) wide, closely covered with conspicuous, convex, pebble-like scales, which toward the outer edge are subcarinated in the middle.

Length 62, breadth 35 mill.

Port Jackson, Australia.

Chiton australis SOWERBY, Mag. of Nat. Hist. (Charlesworth's), June, 1840, p. 290; Conch. Icon., f. 46.—REEVE, Conch. Icon., t. 2, f. 10.—*Lophyrus australis* ANGAS, P. Z. S. 1867, p. 221.—*Lepidoradsia australis* CPR., *MS.* and DALL, Proc. U. S. Nat. Mus. 1878, p. 279, t. 2, f. 19 (dentition); p. 333 (branchiæ).—HADDON, 'Challenger' Rep., Polyplac., p. 19.—*Chiton* (*Ischnoradsia*) *australis* SHUTTLW., Bern. Mittheil., 1853, p. 66.—*C. evanidus* SOWERBY, Mag. Nat. Hist. iv, June, 1840, p. 291; Conch. Illustr., f. 139.—*C. metallicus* RVE., Conch. Icon., t. 17, f. 104, 1847.

This species is distinguished from the following by the fine longitudinal ribbing of the central areas. The synonymy given above is unquestionable.

Occasionally one or more of the teeth is cloven into a number of small ones; the number of teeth varies considerable.

Dall found the gill rows to extend the whole length of the foot, and to contain forty-seven branchiæ in each. Mantle-edge plain, thin; muzzle plain, semicircular, without a veil.

I. NOVÆHOLLANDIÆ (Gray) Reeve. Pl. 19, figs. 67, 68, 69.

Shell oval-oblong, elevated, the dorsal ridge angular, side-slopes nearly straight: Color green, minutely marbled with olive, the lateral areas darker.

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Lateral areas somewhat raised, sculptured with low, uneven, somewhat nodulous radiating riblets, and some concentric growth-wrinkles. *Central areas smooth except for a very dense and regular microscopic granulation.* End valves having radiating riblets; mucro rather prominently raised; posterior slope concave. Interior blue-green, with pink and olive rays. Sutural plates rounded; sinus smooth, not toothed. Anterior valve having about 19, central valves 3–4, posterior valve 18 slits. Teeth thick but sharp; eaves wide, solid.

Girdle covered with smooth, solid, pebble-like scales, which toward the outer edge, are subcarinated. Length 43, breadth 23 mill.

Adelaide, S. Australia.

Chiton novæhollandiæ (GRAY, *MSS.* in Brit. Mus.) REEVE, Conch. Icon., t. 21, f. 142, May, 1847.

This species has much the appearance of *I. australis*, but it differs totally in the sculpture of the central areas, and somewhat in that of the lateral areas. The girdle is just like that of *australis*, except that the pebbly scales are smaller in a specimen of the same size. Carpenter erroneously considered this species a synonym of *Chiton (Radsia) goodalli.*

I. LUGUBRIS Gould. *Unfigured.*

Shell small, solid, punctate, elongate-ovate, slightly carinated, emerald-green. Central areas sculptured with longitudinal liræ, smooth at the apices. Lateral areas elevated, having branching nodulous liræ. End valves radiated at the margins, umbo subcentral. Girdle wide, covered with large transverse convex scales. (*Gld.*)

Interior: end valves having 19–24, central valves 2–4 deep slits; teeth acute, sometimes a little rugose at the margins; eaves very short, spongy; sinus broad, flat, smooth. Girdle imbricated with very solid narrow, nearly smooth scales. (*Cpr.*)

Length 25, breadth 15 mill. (*Gld.*)

Habitat unknown.

Chiton (Lophyrus) lugubris GOULD, Proc. Bost. Soc. Nat. Hist. vii, p. 163, Dec., 1859; Otia Conch., p. 116.—*Lepidoradsia lugubris* Gld., CPR., *MS.*

The girdle, says Carpenter, is very like that of *I. australis*, from which the strong sculpture distinguishes this species.

I. HAKODADENSIS Carpenter, n. sp. Pl. 19, figs. 64, 65, 66.

Shell oval-oblong, moderately elevated, back rather roundly arched, scarcely keeled. Soiled buff, maculated and striped with blackish-brown.

Lateral areas slightly raised, cut into 6 to 9 low flat unequal riblets by radiating impressed lines, the riblets made uneven by concentric wrinkles of growth; central areas very minutely pitted all over, the surface being something between a quincuncial granulation, and a succession of ww-like zigzags. End valves having fine radiating riblets cut by some concentric growth-sulci. Mucro in front of the middle, rather prominent.

Interior blue-white; sinus smooth; sutural plates low, rounded; anterior valve having 15–20, central valves 2–3, posterior valve 15 narrow slits; teeth rather sharp, sometimes slightly roughened; eaves short, narrow, solid.

Girdle covered with small, solid, convex, smooth scales (fig. 66).

Length 25, breadth 15 mill.

Hakodadi, Japan.

This species, which was collected by Wm. Stimpson of the North Pacific Exploring Expedition, has very much the aspect of *I. fruticosus* Gld. of Australia, the sculpture of the central areas being of the same zigzag character. From all species of the *I. longicymba* group, however, this is distinguished by its smooth, convex girdle scales, and by the plurality of slits in the side insertion-plates. The above description and figures are drawn from part of the original specimens.

I. ALBRECHTI Schrenck. Pl. 19, figs. 70–74.

Shell large, oval, elevated, the dorsal ridge acute; mucro median, nearly flat. Reddish maculated with darker, the interior having rays of reddish-brown.

Entire surface minutely and closely punctate; central areas with about 30 lines of granules on each side of, and parallel with, the jugum; lateral areas having in the young 4 to 6, in the adult 10 to 12 radiating, distantly granose riblets; the end valves having 50 riblets.

Interior: posterior valve having 12, central valves 1 to 3, anterior valve about 17 slits; teeth acute, sometimes rugose or lobed at the edges, outside; sinus moderate, 8 to 12 dentate.

Girdle pretty regularly covered with large narrow, solid, smooth scales. (*Cpr.*)

Length 40, breadth 25 mill., divergence 112°.

Hakodadi, Japan.

Chiton albrechtii SCHRENCK, Bull. Acad. Imp. Sci. de St. Pétersb., v, p. 511; Reisen u. Forsch. im Amur-Lande, ii, Zool., p. 283, t. 13, f. 7–17.—*Chiton* (*Lepidopleurus*) *albrechti* E. A. SMITH, Ann. & Mag. Nat. Hist., (4), xvi, p. 115, 1875.—*Lepidoradsia granofilosus* CPR., *MS.*

The form collected by H. C. St. John, R. N. at Endermo Harbor, Japan, is larger, (length 65, breadth of central valves 28 mill.), the lirations on the lateral areas are not granulated, and all the valves are distantly concentrically sulcated.

Subfamily CHITONINÆ.

Lophyroidea CPR.,+*Acanthoidea lophyroidea* and *Acanthoidea typica* CPR., table of Regular Chitons, 1873, and in Dall, Proc. U. S. Nat. Mus. 1881, p. 284 (1882).—*Chitonidæ* and *Acanthopleuridæ* (part) DALL, Catal. Marine Moll. Southeast Coast, Bull. 37, U. S. Nat. Mus., p. 172 (1889.)

Regular Chitons having the insertion-plates well-developed on all of the valves, and closely grooved or pectinated outside and at edge.

The retention of Carpenter's groups *Lophyroidea* and *Acanthoidea* in anything like the limits given by their author, is simply impossible. On the other hand, a perfectly natural group is obtained by uniting these two groups, after excluding the "*Acanthoidea ischnoidea*" Cpr., and the group *Craspedochiton* Shutt., which have special characters not yet noticed in print.

Within the group thus constituted, four genera having well-defined characters are distinguishable, all of them agreeing in the pectinated insertion-plates, though varying in the degree of pectination.

Synopsis of Genera.

A. No eyes developed on the valves.

a. Girdle scaly.

Genus XII. CHITON Linné.

Valves having one or several side-slits in each insertion-plate, and a deticulated sinus separating the sutural plates; girdle scaly, the

scales rounded and solid, closely imbricating, rarely separated. Type *C. tuberculatus* Linné.

aa. Girdle with short bristles.

Genus XIII. EUDOXOCHITON Shuttleworth.

Valves having several side-slits in each insertion-plate, the sutural-plates continuous across the sinus, which is represented by a mere wave; girdle leathery, beset with short, stiff bristles. Type *C. nobilis* Gray.

AA. Eyes developed on end valves and lateral areas.

a. Girdle leathery, nude or nearly so.

Genus XIV. TONICIA Gray.

Valves having pectinated insertion-plates; sutural-plates separated by a squared denticulate sinus; eyes developed in more or less regular rays on forward part of lateral areas and on end valves. Girdle leathery, naked or with a few hairs. Type *C. elegans* Frembly.

aa. Girdle covered with spines or spinelets.

Genus XV. ACANTHOPLEURA Guilding.

Valves having pectinated insertion-plates with one or several side-slits, the teeth in the posterior valve directed *forward* instead of *outward;* sinus denticulate or smooth; eyes small, scattered among the granules of the surface. Girdle bearing long calcareous spines, or closely clothed with short ones. Type *C. spinosus* Brug.

Genus CHITON Linné, 1758.

Chiton L. Syst. Nat. edit. x, p. 667 (first recognizable species *C. tuberculatus*); edit. xii, p. 1006.—Spengler Skrivter af Naturhist. Selsk., 1797 (first species *C. tuberculatus*).—Lamarck, Prodr. Anim. s. Vert., p. 90, 1799 (sole example cited, *C. tuberculatus*).—Wood, Gen. Conch. and Index Test. (*C. tuberculatus* the first species).—Guilding, Zool. Journ. v, p. 27, (example, *C. squamosus* Sowb.=*tuberculatus*).—Gray, P. Z. S. 1847, p. 65, 66.—Shuttlw., Bern. Mittheil. iv, p. 72.—Carpenter & Dall, Proc. U. S. Nat. Mus. i, p. 300 (1878), type *C. tuberculatus*.—Not *Chiton* H. & A. Ad., Gen. Rec. Moll. i, p. 474 (1858.)

Lophyrus (in part) Poli, Test. utr. Sicil. i, *multivalvia*, p. 2, 4, etc. —H. & A. Adams, Gen. Rec. Moll. i, p. 469 (in part.)

Lepidopleurus (in part) Risso, Hist. Nat. Eur. Mérid., p. 267.

Gymnoplax Gray, in The London Medical Repository, Monthly Journal and Review, xv, p. 234 (Jan.–June, 1821.)

Valves wholly external, the beak of the tail valve median or anterior; insertion-plates longer than the eaves, slit into teeth which are deeply and finely pectinated, and typically project outward on all the valves. Girdle covered with closely imbricating, convex, smooth or striated scales. Gills extending the entire length of the foot.

History of names for Chiton. In the tenth edition of his *Systema Naturæ*, Linné includes in the genus *Chiton* the following species: *hispidus*, (" *C. testa sexvalvi striata.* Habitat . . "), *tuberculatus*, *aculeatus* and *punctatus*. Of these the first, *hispidus*, is now universally admitted to be unidentifiable, as no information or reference further than that quoted above is given. The next species is a well-known West Indian form, and has been cited as the first species or type of the genus by Spengler, Guilding, Gray, and nearly all authors. Linné's third species, *aculeatus*, is apparently unidentifiable, but probably belongs to the genus *Acanthopleura*; the fourth, *punctatus*, is if possible less recognizable; and even its modern genus cannot be determined. The name *Lophyrus* Poli has been used for the group by Messrs. Adams, but it can have no standing on account of the fact that Poli proposed that name for the *soft parts only*, retaining the name *Chiton* for the shells, in accordance with his curious system of double naming. Poli's first species of *Lophyrus* is *L. melphictensis*, which is the soft part of *Chiton cinereus* L.! Only one of Poli's four species belongs to the restricted genus *Chiton*. The history of the name *Lepidopleurus* is given on page 2 of this volume. The history of the name *Gymnoplax* is as follows:

Gray, in his article "A Natural Arrangement of the Mollusca according to their internal Structure" (Med. Repos.), under the head of " *Ord.* 10 *Polyplacophora*," enumerates the synonyms of that term, defines the order, and offers the following arrangement:

"*a.* Plates placed on the back of the mantle.

1. Gymnoplax or gymnoplacidæ. Acanthochitona. Chiton facicularis. Leptochitona. Chiton marginatus.

b. Plates sunken in the back of mantle.

2. Cryptoplax. Chiton larvæformis."

The inference from this would be that Gray intended to include in "Gymnoplax or gymnoplacidæ" all Chitons having exposed

valves, a meaning also favored by the etymology; but in P. Z. S. 1847 he places *Gymnoplax* under *Chiton s. s.* as a synonym. In any case, the name *Gymnoplax* cannot be used, as it has never been diagnosed except in the general way quoted above, and no species has ever been expressly designated as belonging to it. The name has been used by Gray only in the instances above mentioned and was, as we have seen, considered a synonym by him in his later writings; but it should be noted that the irrepressible Rochebrune, still uses *Gymnoplax* in a generic sense, in order presumably, to disguise his species;—an unnecessary precaution, for his diagnoses of Chitons generally defy indentification of either genus or species.

In conclusion: it is obvious that the name *Chiton* must be retained for a group typified by one of Linné's original species; and since the *tuberculatus* is the only one of the original list which has been or can be identified, that species becomes the type of the genus. No other position on this question is reasonable or tenable.

The most natural primary division of *Chiton* is into two groups; one to include all American and some Old World species, in which the mucro is anterior and the scales smooth, the other to include Old World species having the mucro subcentral and the scales striated. As this division is based upon characters not always easy to see, the following division into sections is more convenient.

Section CHITON (restricted.)

Median valves having a single slit in each insertion-plate; sinus generally denticulate; scales closely imbricating.

Section RADSIA Gray.

Median valves having two or more slits in each insertion-plate.

Section SCLEROCHITON Cpr.

Median valves having a single slit in each insertion-plate; teeth of tail-valve tending forward; sinus smooth; scales of girdle separated.

Section CHITON *s. str.*

Artificial key to species of Chiton.

A. LATERAL AREAS RADIALLY SCULPTURED.

a. Central areas having longitudinal riblets.

b. Sides and ridge of central areas both sculptured.

c. Umbo of tail valve distinctly in front of the middle.
d. Riblets of lateral areas rather smooth and fine.
e. Dotted or spotted with blue.
f. Large, black, dots small, *magnificus.*
ff. Small; dots large, *murrayi.*
ee. Concentrically lineated with brown or dark, *cumingi.*
eee. Unicolored or blotched.
f. 17 slits in head and tail valves together, *perviridis.*
ff. 22–24 slits in head and tail valves together, *quoyi.*
fff. 35 slits in head and tail valves together, *subfuscus.*
ffff. 30 slits in head and tail valves together, *bowenii.*
dd. Riblets of lateral areas granulose, irregular, or much forking.
e. Lateral areas with 3–4 rows of pustules, *granosus.*
ee. Lateral areas with forking or meshing riblets.
f. Riblets 8–10, fine; slits in head and tail valves together about 40, *virgulatus.*
ff. Riblets coarser, netted; slits fewer, *stokesii.*
cc. Umbo of tail valve about central.
d. Mucro depressed, slope behind it hardly concave, *pellisserpentis.*
dd. Slope behind mucro very concave, *burmanus.*
bb. Central areas with a smooth band or triangular on ridge of each valve.
c. Mucro in front of the middle.
d. Riblets of central areas curved or converging,
e. Lateral areas sparsely pustulose-lirate, *viridis.*
ee. Lateral areas with interrupted or netted liræ, *tuberculatus.*
dd. Riblets of central areas parallel or diverging forward.
e. Lateral areas and end valves pustulose, *granosus.*
ee. Lateral areas and end valves granose-ribbed, *canaliculatus.*
eee. Lateral areas lirate, *nigrovirens, perviridis, densiliratus.*
cc. Mucro about central.
d. Lateral areas with low, smooth riblets, *olivaceus, æreus, affinis.*
dd. Lateral areas with feebly granose riblets, *insularis.*
ddd. Lateral areas with granose or nodose ribs.
e. Lateral areas with 3–4, pleura 25 riblets, *discolor.*

ee. Lateral areas with 2–3, pleura 14 riblets, *muricatus.*

aa. Central areas smooth, lacking longitudinal ribs.

b. End valves granose-lirate or pustulose.

c. Front of diagonal line obviously wrinkled or pitted.

d. Shell and girdle uniform dark green, *rusticus.*

dd. Shell variegated, girdle-scales striated, *sinclairi.*

ddd. Shell or girdle varied, scales smooth, *viridis.*

cc. Front of diagonal line smooth.

d. Pustules scattered; shell and girdle uniform blackish, *marquesanus.*

dd. Finely beaded; shell and girdle banded, *squamosus.*

bb. End valves finely striated.

c. Shell oblong, divergence about 110°. *subfuscus.*

cc. Shell elongated; divergence about 98°. *bowenii.*

AA. Lateral areas smooth or concentrically sculptured.

a. Whole surface smooth.

b. Mucro near the anterior margin.

c. Color black and olive-yellow, with snowy lines, *albolineatus.*

cc. Purple or olive mottled.

d. Sutural-plates within dark-blotched at base; sinus narrow, *lævigatus.*

dd. Sutural-plates within not blotched; sinus wide, *marmoratus.*

bb. Mucro central, *tulipa.*

aa. Central areas longitudinally sculptured, (species not tabulated.)

West Indian species.

Mainly large forms, with smooth scales and notably anterior mucro. They are closely allied to the species of the Panamic region.

C. tuberculatus Linné. Pl. 33, figs. 58, 59, 60.

Shell oval-oblong, rather elevated, carinated, the side-slopes nearly straight. Color varying from light olive to dark green or dark olive-brown, unicolored sometimes, but generally speckled on the side-areas and end-valves, often clouded on the central areas; some of the valves having a dark stripe on the ridge.

Lateral areas raised, sculptured with about 5 cord-like radiating riblets, which are sometimes subcontinuous, but usually are much

interrupted and broken, and bearing a few low tubercles. Central areas smooth along the ridge, the sides sculptured with longitudinal riblets curving inward, becoming coarser outwardly and diverging. End valves closely tuberculate all over, the pattern resembling that of an engine-turned watch case. Umbo of tail valve near the front margin.

Interior blue-green, very smooth, the sutural plates lighter; sinus narrow, toothed. Anterior valve having 13, central valves 1, posterior valve 14 slits; teeth blunt, pectinated. *Slit-rays hardly or not punctate.*

Girdle white, buff or light green, alternating with patches of dark green or blackish. Scales rather coarse, convex, polished.

Length 60, breadth 33 mill. (average Jamaica specimen.)

Length 90, breadth 55 mill. (specimen from Nassau, N. P.)

Bermuda, Florida and Texas to Trinidad.

Chiton tuberculatus LINNE, Syst. Nat. x, p. 667 (1758).—HANLEY, Shells of Linn., p. 12.—*Chiton squamosus* BORN, Test. Mus. Cæs. Vindob., p. 5, t. 1, f. 1.—CHEMN., Conchyl. Cab. viii, f. 788–790.—REEVE, Conch. Icon., t. 3, f. 16.—HADDON, Chall. Polyplac., p. 20, and of all modern authors. NOT *Chiton squamosus* Linné.—*Chiton undatus* SPENGLER, Skrivter af Naturhist. Selskabet iv, p. 68 (1797).—*C. bistriatus* WOOD, Gen. Conch., p. 7 (1815). —*? C. tessellatus* WOOD, l. c., p. 23.

This species has been generally considered to be the *squamosus* of Linnæus, but that the Linnæan name belongs to another species must be regarded as established. The references quoted by Linnæus in the tenth edition of the Systema clearly show that this is the species which he called *tuberculatus*. In the twelfth edition other references not applicable to the species are added; and the figures given by Chemnitz, Born, and others under the incorrect name "squamosus" have caused subsequent authors to adopt the latter name.

This species is the commonest *Chiton* of the West Indies, and is readily known by its (typically) strong, *curved* ribs and peculiar sculpture upon the end-valves, which Reeve aptly compares to that of a lathe-turned watch case. It is extremely difficult to draw a line between this species and *C. assimilis* of Reeve; so difficult, in fact, that I have been unable to satisfactorily distribute a portion of the specimens before me between the two. Linnæus describes tu-

berculatus as *seven-valved;* and oddly enough, one of the specimens collected by Dr. B. Sharp at Tobago is also apparently seven-valved, having two of the valves firmly soldered together the result of an early injury. It is likely that the seven and six-valved Chitons described by early authors were partly abnormal specimens of this character, and the rest were founded upon careless and incorrect figures.

Color-var. Color a uniform dull blackish; riblets of the central areas finer and converging near to the median line. Area behind the sinus inside, and the slit-rays solid, not spongy or porous.

Bermuda.

I have seen a great number of specimens, but mostly so eroded that the permanence of the characters could not be decided.

Var. ASSIMILIS Reeve. Pl. 33, figs. 61, 62.

Fawn colored, with white dots on the lateral areas, the carina banded with brown; girdle light green. *Central areas sculptured with very fine, close riblets.* Interior having the slit-rays and the area behind the sinus porous.

St. Thomas to Barbados.

Chiton assimilis REEVE, Conch. Icon., t. 14, f. 76 (right hand figure); f. 77b. (March, 1847.)

Color-var. *ater.* (pl. 33, fig. 63). Shell having the close fine sculpture of *assimilis,* but black in color, dark green-blue inside.

St. Kitts (Rush); *Trinidad* (Sharp.)

C. SQUAMOSUS Linné. Pl. 35, figs. 80, 81, 82.

Shell oblong, elevated or rather depressed, carinated, the side-slopes somewhat convex. Surface of lateral areas minutely beaded, central areas smooth; *lusterless.* Color buff (pale or deep in tint), the *central areas regularly and conspicuously striped* longitudinally with gray or black, most valves having a wider dark blotch on each side of the keel, and a series of spots along the back edge.

The *lateral areas and end valves are raised and sculptured with radiating rows of fine beads,* the number of rows increasing by interpolation; and *under a lens the surface is seen to be minutely punctate. Central areas not sculptured,* save for inconspicuous growth-lines. Mucro of posterior valve near the front margin.

Interior dark blue-green, the sutural plates lighter. Sinus rudely denticulate. Anterior valve having 12, central valves 1, posterior

valve 13 slits. Eaves narrow, short, somewhat spongy; sinus and slit-rays hardly porous. Teeth pectinated.

Girdle alternately light green and whitish, covered with smooth convex-flattened scales.

Length 60, breadth 32 mill.

Length 45, breadth 28 mill.

Cuba, Jamaica, St. Thomas and St. Croix, West Indies.

Chiton squamosus LINNE, Mus. Ulricæ, p. 465 (1764).—*Chiton squamosus* L., Syst. Nat. xii, p. 1107.—SPENGLER Skrivter af Naturhistorie-Selskabet iv, p. 67, t. 6, f. 2 (1797).—HANLEY, Shells of Linnæus, p. 15 (1855). NOT *Chiton squamosus* of authors.—*Chiton tigris* SPENGLER, *l. c.*, p. 68 (a depressed form; see Chemn. viii, f. 792, 793).—*Chiton scaber variegatus* CHEMN. Abh., p. 31, t. 1, f. 3; Conchyl. Cab. viii, p. 276, t. 94, f. 792, 793.—*Chiton fasciatus* WOOD, Gen. Conch., 1815, p. 10, t. 1, f. 4, 5 (excl. syn.).—SOWB., Conch. Illustr., f. 153.—SHUTTLW., Bern. Mittheil. 1853, p. 74.—*Chiton chemnitzii* PFR., Krit. Register zu Mart. u. Chemn., p. 78, 1840.—*Chiton marmoreus* REEVE, Conch. Icon., t. 12, f. 64 (not of Chemn. nor Fabr.)

This species is colored in much the same fashion as some striped forms of *C. marmoratus*, and it also agrees with that species in the smooth central areas; but the dullness of the surface and the minutely beaded lateral areas at once separate the two forms. Specimens vary greatly in degree of elevation and consequently in the size of the angle of divergence.

Linnæus gives an unusually full description of this species, amply sufficient to distinguish it from the shell which Born, Gmelin, and later authors confused with it. Spengler correctly identified it in his monograph of 1797, and gave a most excellent figure and a good description. Hanley found Linnæus' original type still preserved in his collection, but the *C. squamosus* of authors is not present there. It should be noted that Linnæus' specific names of Chitons were intended to be descriptive of the *girdle*, not the valves.

C. VIRIDIS Spengler. Pl. 33, figs. 64, 65, 66, 67.

Shell oval, moderately elevated, carinated, side-slopes slightly convex. Color varying from gray-white to olive, irregularly marked on the central areas or on the ridge with blackish; sometimes black-brown all over.

Lateral areas strongly raised, and *sculptured with three or four low radiating ribs bearing at irregular or regular intervals low rounded pustules; or having no radiating ribs, the pustules few and irregularly scattered;* posterior border of each valve generally denticulated. *Central areas smooth in the middle,* but *sculptured along the diagonal lines with a series of short ribs bent in the shape of a reversed* S (figs. 66, 67). End valves bearing radiating series of tubercles, or with only a few scattered tubercles. Mucro near the front margin.

Interior *light blue or light green.* Sutural plates lighter, highly arched, the sinus deep, narrow, angular, the straight denticulate portion from $\frac{1}{2}$ to $\frac{1}{3}$ the length of a sutural-plate. Anterior valve having 13, central valves 1, posterior valve 12 slits.

Girdle alternately whitish and brown or green, finely scaly.

Length 36, breadth 22 mill.

St. Thomas and St. Croix (Swift); *Jamaica.*

Chiton squamosus denticularis, etc., CHEMNITZ, Conchyl. Cab. x, p. 372, t. 173, f. 1689.—*Chiton viridis* SPENGLER, Skrivter af Naturhistorie-Selskabet. iv, p. 70, t. 6, f. 5 (1797).—WOOD, General Conch., p. 15 (1815).—*Chiton foveolatus* SOWERBY, Charlesworth's Mag. of Nat. Hist. 1840, p. 290; Conch. Illustr., f. 60.—REEVE, Conch. Icon. t. 6, f. 28.—*Chiton costatus* C. B. AD., Proc. Bost. Soc. Nat. Hist. 1845, p. 8.—*Chiton* (*Lophyrus*) *gemmulatus* SHUTTLEWORTH, Bern. Mittheil. 1853, p. 75.

Doubtful references:—*Chiton squamosus, testa septen-valvi-striata*, etc., CHEMNITZ, *l. c.* x, p. 374, t. 173, f. 1690,=*Varietet af Chiton undatus*, SPENGLER, Skrivter af Naturhistorie-Selskabet, iv, p. 69 (1797).—*Chiton tessellatus* WOOD, Gen. Conch., p. 23 (1815).—*Chiton excavatus* (Gray) SOWB., Conch. Ill., f. 131 (never described.)

This species is well distinguished by the series of short curved wrinkles along the diagonal latero-posterior edges of the otherwise smooth central areas, and by the sutural denticulation, when this is developed, which is by no means always the case. The diagnostic features of the species are stated with great clearness by the Danish naturalist Spengler, and also by Chemnitz, but the figures given by them are poor. There is great variation in the development of the pustules upon the lateral areas and end valves.

C. MARMORATUS Gmelin. Pl. 34, figs. 72, 73, 74, 75, 76.

Shell oval, rather elevated, the dorsal ridge varying from roundly-angular to distinctly carinated; side-slopes convex or straight. *Surface smooth*, polished. Color varying from olive to dark brown or purple-brown, variously marked with darker spots or blotches and light longitudinal stripes or lines.

The lateral areas are a little raised; the whole surface showing a very minute quincuncial pattern of granulation under the lens, and marked with inconspicuous growth-lines. Mucro close to the front edge of the tail-valve, as in *C. lævigatus*.

Interior blue-green, each valve often having darker or olive posterior rays. Sinus deep, angular, having a jagged convex row of denticles, *half as long as a sutural-plate*. Anterior valve having 11–14, central valves 1, posterior valve 13–17 slits; teeth deeply finely pectinated. *Eaves, slit-rays and triangle behind the jugal sinus very porous.*

Girdle alternately blotched with green and light blue.

Length 56, breadth 32 mill.

Length 48, breadth 26 mill.

Texas (Dall); *Bermuda* (Heilprin); *Jamaica* (Cpr.); *Cuba*; *St. Thomas* (Swift); *St. Croix; St. Vincent* (Sharp); *Barbados* (Rush); *and Carthagena, U. S. Columbia* (Krebs.)

Chiton marmoratus GMEL., Syst. Nat. xiii, p. 3205.—(*Chiton marmoreus* CHEMNITZ, Conchyl. Cab. viii, p. 282, t. 95, f. 803–805. Not *C. marmoreus* REEVE).—*C. marmoratus* SOWB., Conch. Illustr., f. 148–150.—REEVE, Conch. Icon., f. 6.—SHUTTLW., Bern. Mittheil. 1853, p. 74.—DALL, Cat. Moll. S.-E. U. S., p. 172.—*C. scarabæus* REEVE, Conch. Icon., t. 12, f. 66.

This species is excessively variable, but with all its variety I have seen no specimens having the *pattern* of the West Mexican *C. lævigatus* and *articulatus*. The following color-patterns are commonly met:

1. Entire surface of valves blackish-brown. This is not an uncommon form, being the *C. scarabæus* of Reeve.

2. Olive, with fine flecks and lines of whitish, becoming confluent toward the middle.

3. Either purple-brown or olive, having longitudinal zebra-like stripes on the side-slopes.

This species is amply distinguished from *C. lævigatus* by the wider sinus, different coloring, and by the much more porous lines radiating toward the slits, and the conspicuously porous triangle under the dorsal ridge of each valve, as shown in fig. 75.

Species of the West coast of the Americas.

This is a natural group of large species, characterized by the generally somber color, large smooth scales, and anterior mucro.

Radsia is a tangent from this circle of species.

C. LÆVIGATUS Sowerby. Pl. 34, figs. 68, 69, 70, 71.

Shell oval, subdepressed or elevated, carinated, the side-slopes somewhat convex. *Surface smooth. Colors soft and blended, varying from purple-gray to olive, lighter in the middle, where there are three irregular longitudinal series of black or dark blotches;* back edge of each valve often articulated with light and dark spots.

The lateral areas are a little raised; whole surface polished, showing a microscopic quincuncial granulation under the lens. *Mucro unusually close to the front edge of the tail valve,* almost marginal.

Interior dark green-blue; the sutural plates lighter but having a large dark green or blackish blotch at the base of each. Sinus deep, square, with a convex row of jagged teeth. Anterior valve having 17, central valves 1, posterior valve 21 narrow slits; teeth blunt, deeply laciniate; eaves short, narrow, spongy.

Girdle wide, tessellated with alternate light and dark.

Length 55, breadth 38 mill.

Length 85, breadth 55 mill.

Gulf of California to Acapulco.

Chiton lævigatus SOWB., P. Z. S. 1832, p. 59; Conch. Illustr., f. 18*.—REEVE, Conch. Icon., t. 7, f. 35.—*Chiton articulatus* SOWERBY, P. Z. S. 1832, p. 59; Conch. Illustr., f. 18.—REEVE, Conch. Icon., t. 2, f. 7.

Sowerby's description of *lævigatus* precedes that of *articulatus* in the P. Z. S., and since the two forms prove to belong to one species, the former name must be accepted. Fig. 69 represents the *articulatus.*

There is considerable variation in the degree of elevation and in the contour, but the extremes seem to be connected most intimately by specimens intermediate in form. This species has a general

resemblance to the West Indian smooth Chiton, *C. marmoratus;* but it differs in the plan of coloring both inside and out, the West Indian species lacking the dark blotches upon the bases of the sutural-plates, which are so characteristic of *lævigatus.* The *marmoratus,* morever, has a proportionately wider sinus, the straight toothed space between the sutural-plates being half as long as each plate, whilst in *lævigatus* it is only one-third as long. This last character, together with the internal coloring, will always distinguish the two species.

C. ALBOLINEATUS Sowerby. Pl. 32, fig. 57.

Shell oblong, parallel-sided, moderately elevated, carinated, *smooth; lateral areas, end valves and dorsal keel black, marked with snow-white radiating lines.* Sides of the central areas light olive-green, some of the valves occasionally black.

The lateral areas are a little raised; entire surface *most minutely* granulated in the usual quincuncial pattern. Beak of posterior valve anterior.

Interior light blue, the sutural plates paler. Anterior valve having 15–16, central valves 1, posterior valve 16–17 narrow slits; teeth strongly pectinated. Eaves narrow, short, spongy. Sinus denticulate.

Girdle firm, blue-gray, compactly covered with convex-flattened polished imbricating scales.

Length 35, breadth 18 mill.

Todos Santos Bay, L. California (R. E. C. Stearns); *Mazatlan* (Cpr.); *Acapulco* (Ruschenberger.)

C. albolineatus SOWB., Zool. Journ. iv, p. 368; in Zool. Beechey's Voy., p. 149, t. 40, f. 4; Conch. Ill., f. 39.—*C. albilineatus* REEVE, Conch. Icon., t. 2, f. 11.—*Lophyrus albolineatus* CPR., Maz. Cat., p. 191.

The apparently smooth surface and the conspicuous snowy stripes render this a very distinct specific type. Each scale of the girdle when examined under a lens is seen to be of a delicate blue-green color, edged broadly with white.

C. MAGNIFICUS Deshayes. Pl. 30, figs. 23, 24.

Shell large, oval, moderately elevated or somewhat depressed, the dorsal ridge indistinctly carinated, side-slopes a little convex. Color *black, with minute blue dots scattered rather thickly over the valves;* girdle black.

The lateral areas are very little raised, and sculptured with about 10 small subobsolete radiating riblets; central areas closely and finely sculptured with longitudinal riblets separated by deeper interstices. Posterior valve having the umbo near the front margin, the slope behind it straight.

Interior light blue; sutural plates wide; sinus square, finely toothed. Anterior valve having 9–12, central valves 1, posterior valve 12–14 slits; teeth stout, blunt, deeply pectinated. Eaves very short and narrow, spongy.

Girdle (fig. 24) strong, covered with shining, convex, imbricating scales.

Length 95, breadth 60 mill.; divergence 120°.

Valparaiso, Chili.

Chiton magnificus Dh., Dict. Class. des Sc. Nat. xii, p. 455; Encycl. Méth., p. 680; Lam., An. s. Vert., ed. Dh., vii, p. 498.—Reeve, Conch. Icon., t. 1, f. 3.—*Chiton latus* Sowerby, Catal. Sh. Tankerv., appendix, p. v, (not *Ch. latus* Lowe).—*Chiton olivaceus* Frembly, Zool. Journ. iii, p. 199, Suppl. pl. 16, f. 4.—*Chiton striatus* Barnes, Amer. Journ. of Science vii, p. 70, t. 3, f. 1. (1824). Not *C. striatus* of authors.

This large olive-black, blue-dotted species is remarkable for the evenness and smoothness of its sculpture. It is an unusually handsome Chiton.

C. murrayi Haddon. Pl. 29, figs. 15–21.

Shell apparently smooth, but really very closely and finely striated, the striæ being roughened or interrupted; greatly depressed.

Anterior valve with radial striæ; under surface with eleven distinct square slits, radial grooves distinct and perforated; teeth of insertion plate serrate. Intermediate valves narrow, flattened, non-carinate, with sharp depressed umbo, surface striæ longitudinal in central areas, radial in the lateral areas; lateral areas distinct, with slight-concentric rugæ, and with three or four scarcely apparent peripheral radial ridges, which die away toward the apex; sutural laminæ shallow, a single lateral slit, lateral insertion plates serrate; jugum with nine rounded teeth, the central being very small. Posterior valve flattened, slightly umbonate, striæ longitudinal on the anterior area, radial on the posterior area; under surface with seventeen distinct slits, teeth serrate; jugum finely toothed.

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Color, upper surface ground color of shell a greenish-grey, slightly clouded with dark brown and black; umbones lighter; on each side of the latter the ground is yellowish; *whole surface sprinkled with pale blue spots*, which are bounded externally by a black line; on the central areas, the spots run in irregular, oblique, backwardly diverging lines, and have a slight tendency to confluence, but on the lateral areas and terminal valves the spots are irregularly scattered; under surface, pale sea-green, darker along the jugum, and with a dark spot at the umbones of the terminal valves.

Girdle: upper surface with large imbricate scales, of which the exposed portion is smooth, the hidden portion being usually finely striated longitudinally; color, dark green, with a tendency to form darker bands opposite the valves; in the angles between the valves a few of the scales are paler and yellowish in color; under surface with long narrow oblong white scales arranged in transverse series.

Gills extending along the whole length of the foot, about fifty-five or sixty in number.

Length 12·5, breadth 7·5 mill.

The following Chitons also have blue spots: *Chiton magnificus* Desh. and *Chiton disjunctus* Fremb. The latter is also from Valparaiso, but it would be impossible to mistake these for *Chiton murrayi*. Superficially, this species bears some resemblance to *Lepidopleurus lentiginosus* Sow. (G. B. Sowerby, 1840, Charlesworth's N. S. London's Mag. Nat. Hist., and Conch. Illust., 1841, figs. 120, 121; Reeve, Conch. Icon., 1847, pl. xxiv, fig. 165,= *Chiton cyaneopunctatus* Krauss, Die südafrikanischen Moll., 1848, pl. iii, fig. 2); but apart from the generic distinction, Sowerby's species can be distinguished by the perfectly smooth shell, inconspicuous lateral areas, paler color of the shell generally, and absence of the external black border to the blue spots. I have given myself the pleasure of dedicating this pretty and distinctive little Chiton to Mr. John Murray of the Challenger Expedition. (*Haddon.*)

Valparaiso, Chili, on the shore.

Chiton murrayi Haddon, Challenger Polyplac., p. 21, t. 1, f. 7; t. 3, f. 7*a*–7*e*.

C. subfuscus Sowerby. Pl. 38, figs. 19, 20, 21, 22.

Shell oblong-oval, elevated, carinated, the side-slopes nearly straight. Surface rather shining. Color dark olive-brown, or olive-

chestnut rayed with brick-red, (or "copperas-green or reddish, more or less flamed with jet-black.")

The lateral areas are somewhat raised, and sculptured with *numerous* (8 *to* 10) *low radiating striæ, which are finely, unevenly interrupted* by growth-lines. Central areas sculptured by some growth-wrinkles, and by *fine longitudinal threads, which are generally obsolete or absent except on the front of the dorsal ridge of each valve.* End valves having radii like the lateral areas, their unevenness giving the valve a superficially pitted or finely netted appearance. Beak of tail valve near the anterior margin.

Interior pale bluish, the sutural-plates whiter. Anterior valve having 15, central 1, posterior valve 20 slits; teeth rather sharp-edged, strongly crenulated inside and out; sinus-area spongy; slits and slit-rays coarsely spongy. Eaves short.

Girdle densely covered with fine, smooth, convex, shining, black or olive-black scales.

Length 42, width 24 mill.; divergence 110°.

Island of Chiloe (Cuming); *Chili.*

Chiton subfuscus SOWERBY, P. Z. S. 1832, p. 26.—*Chiton striatus Barnes*, SOWB., Conchol. Illustr., f. 3, 41 (excl. synon.).—*C. striatus* REEVE, Conch. Icon., t. 1, f. 3*b*. Not *Chiton striatus* BARNES.

This species is closely allied to *C. magnificus*, but differs in being smaller, narrower and more elevated, in lacking blue dots, and in the partial obsolescence of the longitudinal striation of the central areas. Figure 19 represents the form which judging by his measurements Sowerby considered typical. He afteward united *olivaceus*, *latus* and *striatus* (all of which=*magnificus* Dh.) with *subfuscus*. Reeve adopted the name *striatus*, and figured the shell represented by Sowerby's fig. 3 of the "Conchological Illustrations." This is copied in our fig. 20. We are constrained by the terms of Sowerby's original description to adopt the following arrangement.

Typical *subfuscus* Sowb. Pl. 38, fig. 19.

Pale ashy olivaceous green, streaked and mottled with black; longitudinal sculpture all over the central areas, and radiating sculpture on lateral areas, both strongly developed, the latter a little interrupted into rugulations.

The relations of this form with *magnificus* require investigation.

Var. *mesoglyptus* Pilsbry. Pl. 38, figs. 20, 21, 22.

Olive-brown or brown, unicolored or rayed with brick or blood-red, the latter sometimes predominating. Central areas having a group of longitudinal striæ on the dorsal ridge, but smooth or nearly so on the pleura. Smaller than the preceding.

I have seen a considerable number of this form, which is the "var." described by Sowerby and figured in Conch. Illustr., fig. 41. I am unable to say whether it intergrades with the true *subfuscus* or not.

C. BOWENII King. Pl. 38, fig. 23.

Shell large, elongated, elevated, the dorsal ridge carinated; reddish-chestnut, olive, or ashen streaked with olive. Mucro in front of the middle, the slope behind it straight.

Central areas smooth, sometimes with delicate longitudinal striæ at the ridge; lateral areas elevated, delicately radiately striated, the end valves similarly sculptured. The entire surface is microscopically granulated in quincunx pattern.

Inside having 13 slits in the anterior, 1 in the central, 17 in the posterior valve; teeth pectinated, eaves small; sinus wide, flat, with 12–16 teeth.

Girdle olive-brown, in all the varieties of valve-coloring; scales solid, rounded, regularly imbricating, and small for the size of the shell.

Length 82, width 38 mill.; divergence 98°.

Length 68, width 32 mill.

Straits of Magellan.

Chiton bowenii KING, Zoolog. Journ. v, p. 338 (1831 or 1832).—SOWERBY, Conch. Illustr., f. 37.—REEVE, Conch., Icon., t. 2, f. 9.—SMITH, P. Z. S. 1881, p. 35.—ROCHEBRUNE & MABILLE, Moll. Cap Horn, p. 141.

Distinguished by its comparative smoothness, unusually elongated form, and highly ridged back.

C. CUMINGI Frembly. Pl. 30, figs. 29, 30, 31.

Shell oval or oblong, elevated, the dorsal ridge angular, side-slopes nearly straight. Whitish or olive, very *closely and regularly striped with brown or lead-colored lines which are concentric on the end valves and lateral areas and converge forward on the central areas;* often blotched on some or all of the valves with lead-brown or buff.

The lateral areas are separated from the central areas by an oblique curved ridge, but scarcely raised; sculptured with 6 or 7 low radiating riblets, somewhat decussated by longitudinal subobsolete riblets. The central areas are sculptured with longitudinal riblets finer than those of the lateral areas. End valves having radiating riblets and less distinct concentric liræ, the umbo of posterior valve near the front margin.

Interior pale blue; sinus flat, toothed; anterior valve having 10, central valves 1, posterior valve 13 slits; teeth blunt, pectinated.

Girdle clothed with smooth, convex, imbricating scales.

Length 53, breadth 34 mill.

Length 56, breadth 31 mill.

Valparaiso, Chili.

C. cumingsii Frembly, Zool. Journ. iii, p. 198, suppl. pl. 16, f. 3.—*C. cumingsi* Dh. in Lmk., An. s. Vert. vii, p. 500.—*C. cumingii*, Sowb., Conchol. Illust., f. 32.—Reeve, Conch. Icon., t. 1, f. 2.

This well-known species is of a bronze-olive color, closely lineated with brown or olive. The lines are not distinctly enough shown in the figures. The range of variation in contour and color-pattern is considerable. It has been reported from the Cape Verde Is. (Nouv. Arch. du Mus. 1881, p. 282), but there cannot be much doubt that the citation is based on a false locality label.

*

C. stokesii Broderip. Pl. 30, figs. 25, 26; pl. 32, figs. 50–53.

Shell oval, moderately elevated or depressed, the back carinated, side-slopes straight. Brownish-black, toward the middle often more or less marbled longitudinally with dirty white.

Lateral areas somewhat raised, closely sculptured with radiating, *irregularly granulous and anastomosing riblets.* Central areas sculptured throughout with low close longitudinal riblets, often made slightly granose by the lines of growth. End valves covered with a net-work of nodose riblets generally very much interrupted; umbo of posterior valve near the front margin.

Inside smooth, varying from blue-white to light blue, the sutural plates paler, all of the valves marked with a spot of dull brown. Sinus deep, rather narrow and angular, jaggedly toothed. Anterior valve having 16, central valves 1, posterior valve 15–16 slits.

Girdle (pl. 32, figs. 53) covered with solid, convex, subcarinated imbricating scales. Length 68, breadth 50 mill.

Guaymas, West Mexico, to Panama and West Columbia.

Chiton stokesii Brod., P. Z. S., 1832, p. 25.—Sowb., Conch. Illustr., f. 24.—Reeve, Conch. Icon., t. 1, f. 4.—Morch, Mal. Bl. vii, p. 176.—*Chiton patulus* Sowb., Charlesworth's Mag. Nat. Hist. 1840, p. 291; Conch. Illustr., f. 134.—Reeve, Conch. Icon., f. 30.—*C. interruptus* Cpr., *MS.*

The sculpture of the lateral areas is peculiar, being something like the meshes of a stretched net, but the cords or riblets are irregularly granulose. In uniting the *C. patulus* of Sowb. to *stokesii*, I quite agree with Carpenter, who writes as follows: The form *patulus* is typically "engine-turned" on the terminal valves, with strong rugæ on the sides, and larger scales on the girdle. A young specimen sent by Mr. Cuming has only 18 slits in the tail plate. The typical *stokesii* has the terminal rugæ radiating, and sometimes a row of color dots at the sutures. The bulk of the Panama and San Juan specimens (of which I have examined many hundreds) are so variously intermediate between the two forms that I find it impossible to separate them even as varieties. The scales are extremely deciduous, and specimens in good condition are not often found. It was often the custom of Mr. Cuming to select extreme forms for his cabinet; and these being described and figured as the normal types of species are very apt to mislead students who work by single specimens.

C. virgulatus Sowerby. Pl. 32, figs. 54, 55, 56.

Shell oblong, parallel-sided, rather elevated, the dorsal ridge carinated, side-slopes straight. Lateral areas and end valves olive-brown, or like the central areas which are green, longitudinally clouded with blackish; *girdle firm and solid*, transversely or longitudinally banded.

The lateral areas are raised and sculptured with *numerous* (8–10) *radiating riblets, which have a tendency to split* or branch. Central areas sculptured with longitudinal riblets which at the sides diverge a little and are nearly as coarse as those of the lateral areas, but become finer and parallel to the ridge toward the middle. End valves having close radiating riblets; apex of tail valve anterior.

Inside dark *blue-green;* sutural-plates high, blue-green. Sinus deep angular and toothed. Anterior valve having 21–22, *central*

valves 1 *or* 2, posterior valve 19–20 wide spongy slits; teeth wide, blunt, pectinated; eaves short, narrow, spongy.

Girdle compactly covered with solid, *shining* convex scales (pl. 32, fig. 56.)

Magdalena Bay, L. California; *Gulf of California.*

Chiton virgulatus SOWB. in Charlesworth's Mag. Nat. Hist. 1840, p. 291; Conch. Illustr., f. 132.—REEVE, Conch. Icon., t. 21, f. 140.

This species is allied to *C. stokesii*, but differs in being narrower, more elevated, differently colored, in having the riblets finer, more numerous and less anastomosing, in the color of the interior and in the number of slits, which is much greater in the end valves of this species than in those of *C. stokesii*, and in some of the intermediate valves there are two slits in one or both sides. The entire surface, as usual in this genus, is microscopically granulated. The girdle-scales are finer and smoother than in *C. stokesii*, and the sutural-plates are different in form.

A square mm. of the girdle is shown by the dotted line in fig. 56.

It has been reported from Australia, but erroneously. Many specimens are before me from the localities given above.

The remarkable feature of this species is that it forms a perfect transition between the restricted genus *Chiton* and the section *Radsia*. Some specimens have two slits in one end of one valve only; others have two slits in the majority of the valves; and scarcely two are alike in the arrangement of 1- and 2-slit insertion-plates. I have examined the interior in about a dozen individuals and have always found at least one insertion-plate Radsioid, but probably a larger series would reveal specimens with the normal plates of *Chiton s.-s.*

*

C. GRANOSUS Frembly. Pl. 30, figs. 27, 28.

Shell oval-oblong, moderately elevated, scarcely carinated, the side-slopes somewhat convex. *Black, having a white stripe on each side of the central line*, clouded with whitish between the stripes.

Lateral areas bearing three or *four rows of bead-like pustules*, on a smooth ground; *central areas having a narrow smooth dorsal band, the sides (pleura) covered with close, fine longitudinal riblets*, which are more or less crenulated by the growth-lines. End valves having rounded pustules in radiating rows or irregularly scattered; umbo of tail valve near the front margin.

Interior whitish clouded with olive-plumbeous posteriorly and on the sutural-laminæ; sutural-plates wide, sinus rounded, toothed; anterior valve having 14–15, central valves 1, posterior valve 15–18 slits; teeth blunt, pectinated; eaves short, spongy. The sutural laminæ are smooth inside, *the anterior-median tract is finely wrinkled transversely*, the posterior tract is punctate.

Girdle clothed with coarse, angularly-convex, imbricating scales.

Length 40, breadth 26 mill.

Gulf of Pendas, Patagonia; Valparaiso, Chili.

Chiton granosus Frembly, Zool. Journ. iii, p. 200, suppl. pl. 17, f. 1 (1827).—Dh. in Lmk., An. s. Vert. iii, p. 500.—Sowb., Conch. Illustr., p. 2; Moll. [Beechey's Voyage of H. M. S. 'Blossom,' t. 40, f. 5.—Reeve, Conch. Icon., t. 5, f. 27.—*Lophyrus granosus* Tap. Can. Viag. 'Magenta' p. 75.

The pustulose lateral areas and end valves and the black, two-striped color-pattern are the stronger features of the exterior of this species; and the interior is no less strongly marked by the transverse wrinkling of the front part of each valve, which may be readily seen under the lens without dis-articulating the shell. This wrinkling in other species is confined to a band the width of the sinus, and is much less strongly developed. The second valve is broad and beaked, with only a narrow smooth dorsal line; the following valves have a distinct smooth band.

*

C. striatosquamosus Carpenter.

Shell subrotund, depressed, pale brown-olive; entire surface of the valves densely granulated; lateral areas rather distinct, valves wide, slightly curved, scarcely beaked; jugum scarcely distinct, very delicately longitudinally striated, lateral margins planate; mucro superior, slightly distinct.

Girdle furnished with solid, oval, large hardly crowded scales, part deeply striated; margins of the valves serrated; median valves with a single slit on each side, end valves having about 12 slits; sutural-plates large, strongly arcuate.

Length 4½, breadth 3, alt. 1 mill.; divergence 140°. (*Cpr.*)

Mazatlan, on Spondylus calcifer.

Lophyrus striato-squamosus Cpr., Cat. Mazat. Sh., p. 192.

Species of Japan, East Indies, Polynesia, etc.

C. AQUATILIS Reeve. Pl. 38, figs. 33, 34.

Shell ovate, valves very closely elevately striated throughout, striæ here and there but rarely, bifurcately-divergent, interstices rather excavated. Bronze-green, yellowish in the middle, with narrow transverse green bands. Ligament squamately coriaceous, scales pale sea green.

A peculiar smoothly bronzed shell, painted across the middle with narrow bands or ripples of green. (*Reeve.*)

Tsu-sima, Japan.

C. aquatilis REEVE, Conch. Icon., f. 73.

Reeve gives no locality for this species. The figures on my plate are copies of his.

Carpenter writes as follows of Reeve's type specimen: One specimen made up of two, only the valves stuck together. I counted just eleven scales in one corner, though Reeve describes and figures it as complete. The very insertion-plates are in great measure rubbed off. It may equal my *C. densiliratus* in poor condition. Anterior valve having 10, central valves 1, posterior valve 13 slits; teeth pectinated; eaves short. Shell rather elevated, the dorsal ridge sharpish. Central areas with extremely close fine parallel striæ, jugal area not defined. Lateral areas not elevated, having 18 radiating lines, extremely close and fine, as on central areas, but rather more developed; the end valves similarly sculptured, mucro in front of the middle; posterior slope very concave. Marked "? Japan"; and the habitat of a specimen sent by Damon for purchase is Tsu-sima, Japan. The valves alone, without girdle, and irregularly placed measure:

Length 40, breadth 23 mill.; divergence 105°.

C. DENSILIRATUS Carpenter, n. sp.

Shell oval, solid, elevated, the jugum acute; mucro scarcely prominent, subanterior. Ashy or pale brown, irregularly clouded with chestnut or black, often elegantly dotted with darker or paler.

Central areas having about 25 riblets on each side of the jugum and parallel with it, obsolete at the ridge; lateral areas well defined, having 8–10 liræ, sometimes bifurcating; end valves having 60–70 such liræ.

Inside: anterior valve having 8; central valves 1, posterior valve 18 slits; teeth normal, very closely pectinated; sinus narrow, having about 12 minute denticles.

Girdle unicolored or tessellated, bearing normal imbricating scales which here and there are very minutely striatulate.

Length 58, width 33 mill.; divergence 110°.

Japan (Mus. Cum., no. 16.)

This species, says Carpenter, from whose *MS.* the above description is taken, is easily recognized by the very close ribs, arranged like miniature whale bone.

C. MARQUESANUS Pilsbry, n. sp. Pl. 36, figs. 98, 99, 100.

Shell oval-oblong, depressed, obtusely carinated, the side-slopes nearly straight. *Surface smooth and polished on the central, granose and lusterless on the lateral areas.* Color dark olive-green, almost black on the lateral areas and end valves.

Lateral areas but slightly raised, sculptured with about seven uneven and unequal rows of separated low warts, and under a lens seen to be covered with a minute granulation; central areas shining, having a few low growth-wrinkles and covered with a partly effaced microscopic granulation. End valves closely granose in indistinctly radiating pattern; mucro near the front margin of the tail valve.

Interior light blue, stained at sinus and under the beaks with purple-brown; sinus rather shallow and toothed. Anterior valve having 21, central valves 1, posterior valve 25 slits.

Girdle dark green, covered with convex scales, which in the middle of its breadth are larger and carinated.

Length 46, breadth 26 mill.

Marquesas Is. (Garrett.)

The papillose lateral areas, smooth central areas and uniform dark olive-green color are the more striking features of this species. The large number of slits is also noteworthy. The specimen before me was presented to the Academy by the late Andrew Garrett, and it was labelled "*C. marquesana;*" but whether this name was given by Garrett or by Tryon I do not know.

C. PERVIRIDIS Carpenter.

Shell small, narrow, elevated, the jugum acute; color an intense green. Entire surface very minutely scaly under a lens; lateral areas and end valves radially lirate, the liræ obtuse, little conspicuous, 4 or 5 on side-areas, 20–25 on end valves. Central areas

having about 12 little impressed, distant sulci, parallel to the dorsal ridge. Mucro anterior-subcentral, moderately projecting. Interior having 8–9 slits in end valves, 1 in median valves; teeth acute, deeply pectinated; eaves short; sinus wide, flat, toothed. Girdle furnished with large, solid, imbricating but striated scales.

Length 11¼, width 6¼, alt. 3 mill.

Tahiti (Pease.)

Chiton (Lophyrus) perviridis Cpr., P. Z. S. 1865, p. 511.—*Lophyrus perviridis* Pease, Amer. Journ. Conch. vii, p. 194.

A solitary specimen of this interesting species is very like *C. virescens* Rve. in general appearance; but the mantle of that species is nearly smooth and the valves scarcely sculptured. This shell is of a uniform bright green. It has the aspect of *Lepidopleurus* [Lepidozona]; but the insertion-plates though sharp, are deeply pectinated. It differs from most other *Chitons* in having the scales distinctly striated, as in *C. striatosquamosus.* (*Cpr.*)

C. burmanus Carpenter, n. sp.

Shell elevated, with *acute dorsal ridge;* olivaceous or red, *having a white blotch on the tail valve behind the mucro.*

Whole surface of the valves finely quincuncially granulated; central areas having *about* 20 *sharp and distinct ribs on each side,* parallel to the dorsal ridge, upon which they are finer and closer; *lateral areas having* 3 *to* 5 *rows of stout granules,* some of the rows not reaching to the apex. End valves having 25 (or fewer) rows of stout granules. Mucro of the tail valve median, *the slope behind it very concave.*

Interior having 8 slits in the anterior, 1 in the median, 11 in the posterior valve; teeth sharp but distinctly pectinated; eaves short.

Girdle covered with rather roundish oval scales of large size.

Length 19, breadth 10½ mill.; divergence 96°.

Coast of Arakan, British Burmah, under stones at low water.

The British Museum contains four specimens, of which three are olivaceous, the other red. The above description is from Carpenter's *MS.*

Species of Australia, New Zealand, etc.

The species of these regions are mostly of moderate or small size, and generally the mucro is central and the scales microscopically striated.

C. QUOYI Deshayes. Pl. 37, figs. 6, 7, 8.

Shell oval, rather elevated, carinated, the side-slopes straight. Surface having a smooth and polished appearance but very finely striated. *Color generally a very dark olive-green*, but sometimes yellowish-brown marked with olive on the sides and ends, or clear yellow with rays of olive or brown.

Lateral areas slightly raised, sculptured with numerous narrow, delicate and slightly crenulated radiating threads. Central areas covered with still finer longitudinal striæ. End valves sculptured like the lateral areas, the two about equal in size; mucro of the rather raised tail valve a little in front of the middle.

Interior sky-blue, marked under the beaks with olive-brown rays. Sinus rather square, finely denticulate. Anterior valve having 9–10, central 1, posterior 13–14 slits; teeth crenulated outside.

Girdle covered with smooth convex imbricating scales, mostly light blue, but often having dark brown scales mingled with them.

Length 37, breadth 22 mill.

Auckland to Dunedin, New Zealand, in pools under stones, between tides.

Chiton viridis Q. & G., Voy. Astrol. iii, p. 383, t. 74, f. 23–28 (1834). Not *Chiton extus viridis, intus candidus* of Chemnitz, Conchyl. Cab. viii, p. 277, t. 94, f. 794, 795 (1785), nor *Ch. viridis* Spengler, *q. v.*—*Chiton quoyi* DESH. in Lam., Anim. s. Vert. vii, p. 509 (1836).—REEVE, Conch. Icon., t. 13, f. 68 (1847).—*Chiton glaucus* HUTTON, Man. N. Z. Moll., p. 112 (1880.)

? *Chiton glaucus* GRAY, Spicilegia Zoologica pt. i, p. 5 (1828).—? *Lophyrus glaucus* ANGAS, P. Z. S. 1867, p. 222.

This species differs from all other true Chitons of New Zealand in its finely sculptured, comparatively smooth surface, resembling in this respect the *C. magnificus* of South America. It is a well known New Zealand form, and has also been reported from Port Jackson, Australia, by Angas, under the name *glaucus;* but I have not been able to confirm this by the comparison of specimens from the latter locality, which may safely be omitted until authoritatively confirmed.

The locality of Gray's *C. glaucus* was unknown, he did not figure his specimen, which had lost its girdle, and he states that it was white inside, glaucus green outside. The identification of Quoy and Gaimard's well described and figured shells from New Zealand with

Gray's species is therefore highly hypothetical; especially since no one seems to have seen Gray's type, and its generic characters are wholly unknown. I have never seen a "glaucus green" specimen of this species "white inside;" they are always blue. The change of name made by Deshayes must be adopted on account of the earlier *C. viridis* of Spengler.

*

C. PELLISSERPENTIS Quoy & Gaimard. Pl. 37, figs. 14, 15, 16, 17, 18.

Shell oval, rather elevated, hardly carinated, the side-slopes somewhat convex. Surface lusterless. Color a rather dull and dingy olive or olive-green marked with black along the ridge and on the sides of some valves.

The lateral areas are moderately raised and sculptured with 3 *or* 4 *rows of distinct tubercles.* Central areas having *strong, irregular growth wrinkles, and fine longitudinal riblets.* Anterior valve larger and much more elevated than the posterior, both being sculptured with numerous regular rows of distinct tubercles, the rows increasing by splitting. Posterior valve depressed, the low mucro in front of the middle.

Inside blue, indistinctly blotched with olive-green. Sutural-plates rounded, the sinus broad and deep, smooth or hardly denticulate. Anterior valve having 12, central valves 1, posterior valve 12 slits; teeth blunt, pectinated. Eaves broad.

Girdle wide, alternately light and dark; scales (pl. 37, fig. 17) rather large and wide, often showing a slight tendency to carination in the middle, microscopically striated.

Length 30, breadth 23 mill.

New Zealand.

Chiton pelliserpentis Q. & G., Voy. de l'Astrolabe, Zool. iii, Moll., p. 381, t. 74, f. 17–22 (1834).—DESH., in Lam., An. s. Vert. vii, p. 508 (1836).—*Chiton pellis-serpentis* REEVE, Conch. Icon., t. 15, f. 84.—HUTTON, Cat. Mar. Moll. N. Z. 1873, p. 46; Man. N. Z. Moll. 1880, p. 111.—HADDON, Challenger Polyplac., p. 22.

This is one of the most abundant New Zealand Chitons. Its sculpture is frequently obscured or lost by erosion. *C. sinclairi* is closely allied, but it differs in color-pattern, in the *polished* central areas, whilst the surface of *pellis-serpentis* is lusterless, and in the sculpture of the central areas. The median valves of *pelliserpentis*

are rather strongly arched backward, and the broad sinus is remarkable for the absence or obsolescence of teeth. The interior, except just behind the sinus, is smooth; the callus in each valve is heavy and smooth. Figures 14, 15, 17 are drawn from Auckland, N. Z. examples, furnished by Mr. G. W. Wright.

C. SINCLAIRI Gray. Pl. 36, figs. 1, 2, 3.

Shell oval, rather elevated, the *dorsal ridge rounded*, side-slopes rather straight; *brown-black*, each valve *irregularly and raggedly striped with whitish;* the head valve pale with dark rays. Sometimes the white predominates.

The lateral areas are raised and sculptured with *three or four radiating granose ribs, often subobsolete.* Central areas *smooth in the middle except for a few growth-wrinkles,* but having *fine short longitudinal riblets at the sides in front of the diagonal line.* These riblets are sometimes almost obsolete. Head-valve sculptured at first with about 15–18 granose riblets, but as these have a tendency to split as the valve grows, the number in a grown specimen is usually 24–30. Tail-valve having a low, obtuse mucro, decidedly in front of the middle.

Interior bluish. Sinus rather wide, denticulate, the area behind it porous. Anterior valve having 11, central valves 1, posterior valve 14 slits; teeth obtuse, strongly crenulated. Eaves broad, spongy.

Girdle (pl. 36, fig. 3) covered with large, convex scales, which are very finely, sharply striated.

Length 28, breadth 18 mill.

Length 17, breadth 11 mill.

New Zealand (Sinclair, Hutton, Wright.)

Chiton sinclairi GRAY, in Dieffenbach's Travels in N. Z. ii, p. 263 (1843).—HUTTON, Trans. N. Z. Inst. iv, p. 177; Man. N. Z. Moll. p. 111 (1880).—SMITH, Zool. 'Erebus' and 'Terror,' p. 4, t. 1, f. 17.—REEVE, Conch. Icon., t. 22, f. 143.

The smooth, polished central areas, grooved only along the diagonal line at the sides, and the granose-ribbed lateral areas and end valves are characteristic, and remind one of the West Indian *C. viridis*. The black-and-white coloring also is rather constant. The sculpture of the side-areas varies greatly in strength. This species has been reported from Tasmania, but on doubtful authority.

C. DISCOLOR Souverbie. Pl. 60, figs. 3, 4.

Shell ovate-oblong, the back carinated, umbones subrostrate; gray-green or yellowish-red, with longitudinal more or less pallid and more or less numerous spots. End valves ornamented with about 20 radiating series of quite strong tubercles (some of the rays being short, intercalated between the others); lateral areas having three series of tubercles and a fourth intercalated shorter series. Central areas sculptured on each side of the smooth dorsal carina with impressed, subobliquely longitudinal grooves. Girdle leathery and scaly. Dimensions, exclusive of the girdle, which is very incomplete in our two examples (probably immature); length 19, breadth 9½ mill. (*Souv.*)

Art Island, N. Caledonian Archipelago (Mus. Bordeaux.)

Chiton discolor SOUV., Journ. de Conch. 1866, p. 252, t. 9, f. 1, 1a. —*C. miniaceus* CPR., *MS.*, Mus. Cuming.

Carpenter's unpublished species seems to be the same as this, although until the types of *discolor* are examined, we cannot be certain. Carpenter's description here follows:

C. miniaceus Cpr. Shell elevated, oval, the jugum acute; vivid vermilion, the margin tessellated with paler. Mucro median, little elevated. Entire surface minutely punctate; central areas having about 25 subparallel grooves on each side, obsolete on the dorsal ridge; lateral areas elevated, bearing 3–4 strong, radiating liræ, which are strongly nodose. End valves having about 20 liræ. Interior: anterior valve having 8, central 1, posterior 10 slits; teeth deeply pectinated; sinus wide, minutely denticulated. Girdle covered with normal imbricating scales.

Length 27½, breadth 20 mill.; divergence 100°.

New Caledonia.

Mus. Cum., no. 59. Easily recognized by the strong sculpture and brilliant vermilion color. (*Cpr.*)

C. MURICATUS A. Adams. Pl. 37, figs. 12, 13.

Shell oblong, much elevated in the middle; black-brown and white variegated. End valves and *lateral areas radiately ribbed, the ribs ornamented with elevated acute grains;* tail valve umbonated in the middle. Central areas longitudinally deeply lirate, the umbones smooth, elevated, somewhat produced. Girdle scaly, the scales mucronated, imbricating, with suberect apices. (*Ad.*)

This species is remarkable for the somewhat triangular imbricate scales of the ligament *ending in sharp pointed mucrones;* the ligament is tessellated with pale fuscous and dark brown; the ribs on the lateral areas are four, muricated with sharp granules. (*Ad.*)

Sydney, N. S. Wales, Australia, under stones at low water. (Strange.)

Chiton muricatus A. Ad., P. Z. S. 1852, p. 91, t. 16, f. 6.—*Lophyrus muricatus* Angas, P. Z. S. 1865, p. 186; 1867, p. 222.—*Chiton limans* and *C. carnosus* Cpr., *MSS.*

Varies in color from dull green to orange and buff.

Carpenter examined Adam's type of this species, and ascertained it to be identical with his own unpublished *C. limans*; the description of which here follows:

Shell oval, elevated, the jugum acute; mucro median, subprominent; olivaceous, maculated with paler; entire surface minutely punctate; central areas having about 14 grooves on each side, obsolete in the middle; lateral areas having two riblets, sometimes bifurcating or with another intercalated, furnished with strong acute tubercles, interstices smooth; end valves with 10–20 such riblets. Interior: anterior valve having 8, central 1, posterior valve 9 slits; teeth normal; sinus moderate, with about 15 denticles. Girdle furnished with large and small wide, distinctly striated, elevated, acutely pointed scales.

Length 23¾, breadth 12½, divergence 100°.

The points of the striated scales project, as in *Isch. australis*, so as to give the girdle a rasp-like appearance.

Var. *aurantius* Cpr. Shell smaller, pale orange colored, dotted with more intense; posterior valve with 10 slits.

Length 17½, breadth 10 mill.; divergence 100°.

Like the preceding in all important characters, but differing remarkably in color and pattern.

A form in which the sculpture of the side areas is less developed received the name *carnosus* Cpr. The original description in Carpenter's *MS.* before me, indicates the following as the most important characters of *carnosus:* Central areas having about 18 subparallel sulci on each side, more prominent toward the margin, obsolete toward the jugum; lateral areas and end valves having irregularly (at the sutures strongly) nodose wrinkles, 4 in number on the side areas, 22 on the anterior, 14 on the posterior valve, sometimes

bifurcating. Interior: anterior valve with 8, central 1, posterior valves 10 slits. Length 30, breadth 15 mill.; divergence 105°.

Sydney.

Easily recognized by the fleshy color and small, beaked, mantle-scales; the side sculpture of *limans* (with which this species agrees in the scales) is very different in pattern. (*Cpr.*)

C. CANALICULATUS Quoy & Gaimard. Pl. 36, figs. 4, 5, 6.

Shell small, oblong, *strongly elevated, carinated*, the side-slopes straight, steep. End valves and lateral areas pink, central areas yellowish, dorsal ridge pink with an olive-green stripe on each side. Sometimes olivaceous, or olive and rose.

The lateral areas are strongly raised and sculptured with 4 or 5 radiating ribs which are regularly cut into low beads, and which often split toward the lower margin. Central areas having a narrow smooth space upon the ridge, sculptured on each side with about 16 strong longitudinal ribs, separated by deep intervals; posterior margins of valves crenulated. Anterior valve having about 22 granose radiating ribs; posterior valve having about 16 granose radiating ribs, the umbo slightly in front of the middle, the slope behind it a little concave. Interior whitish; sinus rather deep and narrow.

Girdle covered with compactly imbricating, convex, shining obsoletely striated small scales (pl. 36, fig. 6.)

Length 14, breadth 11 mill.

Tasman Bay's (Q. & G.), *and Stewart Island* (Hutton), *New Zealand.*

Chiton canaliculatus Q. & G., Voy. Astrol. Zool. iii, p. 394, atlas, t. 75, f. 37–42 (1834).—*Chiton stangeri* REEVE, Conch. Icon., t. 22, f. 150 (1847).—*Chiton insculptus* A. ADAMS, P. Z. S. 1852, p. 91, t. 16, f. 4.—*cf.* HUTTON, Man. N. Z. Moll. 1880, p. 111, 112.

Allied, in its acutely elevated contour, to *C. jugosus*, but differing markedly in the granose-ribbed lateral areas. It is usually very brilliantly colored with rose-pink and buff, but olivaceous forms also occur. The latter may be distinguished from *C. sinclairi* by the differently sculptured central areas. Professor Hutton (*in litt.*) suggests to me the identity of *stangeri* and *insculptus*. The latter seems to agree altogether with Quoy's *canaliculatus*.

The girdle-scales (pl. 36, fig. 6) are smaller than in *C. jugosus*, and they are much less distinctly striated than in *C. sinclairi* or *C. pellisserpentis*.

C. JUGOSUS Gould. Pl. 36, figs. 91, 92, 93, 94, 95.

Shell oblong, much *elevated*, carinated, the side-slopes straight and steep. *Central areas sulcate at the sides, smooth in the middle, lateral areas smooth. Color light green, the ribs of the central areas orange*, lateral areas with fine alternating concentric lines of yellow and green.

The lateral areas are strongly raised and smooth, painted with close lines parallel to the dorsal keel. Central areas having a smooth triangle in the middle, the sides sculptured with 11–14 strong rounded orange colored ribs, separated by deep, blue intervals of the same width. Head valve smooth, concentrically lineated; tail valve concentrically lined at the sides, having a *broad triangular buff or orange ray behind*, extending across the girdle; *apex projecting slightly behind the middle, posterior slope strongly concave.*

Interior blue-white, the sutural plates white. Sinus narrow and angular, denticulate. Anterior valve having 8, central valves 1, posterior valve 12 slits; teeth blunt, pectinated. Eaves spongy.

Girdle (fig. 95) buff and greenish, irregularly alternating, covered with compactly imbricating, polished convex scales, which are obsoletely striated. Length 35, breadth 20 mill.

Port Jackson, Sydney, N. S. Wales, Australia.

Chiton jugosus GOULD, Proc. Bost. Soc. N. H. ii, p. 142 (1846); Expl. Exped. xii, Moll. & Sh., p. 317, atlas, t. 28, f. 430 (1852).—SMITH, Zool. Coll. H. M. S. 'Alert,' p. 78 (1884).—HADDON, Chall. Polyplac., p. 22 (1886).—*Lophyrus jugosus* GLD., Otia, p. 3, 242 (1862).—ANGAS, P. Z. S. Lond. 1867, p. 222.—*Chiton concentricus* REEVE, Conch. Icon., t. 16, f. 95 (1847).—*Lophyrus concentricus* ANGAS, P. Z. S. 1867, p. 221.

The peculiar and beautiful coloration separates this species from its allies. The second valve is frequently blood red, or blotched at the sides with dark sepia; and occasionally all or many of the valves have blotches of buff interrupting the longitudinal color-lines. The light triangle radiating backward from the umbo of the tail valve is present in every specimen I have seen. The tail valve, indeed, reminds one somewhat of that of an irregular Chiton.

The painting of the lateral areas gives the impression that they are longitudinally ribbed, as Reeve and Angas have described; but even in Reeve's types these areas are quite smooth, as they are in all the specimens I have seen.

This species has been reported from New Zealand, but probably incorrectly.

C. PULVINATUS Carpenter, n. sp.

Shell small, oval, subelevated, with acute jugum; mucro median; apices of the valves prominent; olivaceous and brown variously clouded and irregularly painted. Entire surface minutely punctulated; *central areas having about* 16 *deep sulci on each side; lateral areas well defined, nearly smooth,* as are the end valves also.

Interior: anterior valve having 10, central valves 1, posterior valve 9 slits; teeth acute, deeply serrated; sinus moderate, denticulate.

Girdle covered with large smooth scales.

Length 9, width 4½ mill.; divergence 110°. (*Cpr.*)

New Ireland (Mus. Cuming, no. 78.)

Distinguished from *luzonicus* by the smooth scales and side-areas, which display a velvety appearance under the microscope.

*

C. ÆREUS Reeve. Pl. 36, figs. 96, 97.

Shell oblong-ovate, angularly raised in the middle; valves rudely impressly striated throughout, umbonal eminence smooth. Dull green; ligament granosely coriaceous.

The color is a uniform dull green except along the rubbed umbonal summit, where it has a copperas hue. (*Rve.*)

New Zealand (Earl.)

Chiton æreus REEVE, Conch. Icon., t. 7, f. 36 (1847).—*Chiton* (*Leptochiton*) *æreus* SMITH, Zool. Voy. 'Erebus' and 'Terror' Moll. p. 4, t. 1, f. 9.—*Ch. siculoides* CPR., *MS.*

This species has been referred by Smith to *C. siculus* Gray. The locality requires confirmation, as it rests solely upon Cumingian specimens. Hutton (Man. N. Z. Moll.) reprints Reeve's diagnosis without comment.

Carpenter's notes on Reeve's type are as follows: Central areas having about 20 furrows on each side, not deep, continuing until they are rubbed off in the middle; lateral areas having 4–8 divaricating riblets, much worn, broken up by the concentric rugæ of growth; crenate at the sutures; end valves with about 30 riblets. Mucro in front of the middle, posterior slope concave. Interior

bluish, sinus with 5–13 denticles, deep, narrow; girdle scales stout, roundish. Length 39, breadth 23, divergence 94°.

One specimen, *New Zealand*, in Mus. Cuming.

Species of the Mediterranean and African Seas.

The species are allied to those of Australia and New Zealand, the mucro in many of them being central, and the scales striated.

C. OLIVACEUS Spengler. Pl. 35, figs. 87, 88, 89, 90, 91, 92.

Shell oblong, *elevated*, carinated, the side-slopes straight. Surface ribbed and microscopically punctulate. Color very variable; either black, brown, scarlet or olive-green, unicolored or clouded or mottled.

Lateral areas raised, *sculptured with* 4–6 *flat low radiating ribs*, the posterior rib widest, separated by narrow shallow grooves. *Central areas having a smooth triangle on the ridge of each valve, the sides* (*pleura*) *bearing strong longitudinal ribs*, which become stronger toward the outer margin. End valves having low radiating riblets. *Tail valve having a conspicuous central apex*, the posterior slope somewhat concave.

Interior light bluish, marked with brown rays in each valve. Sutural plates rounded; sinus deep, square, denticulate. Anterior valve having 7–8, central valves 1, posterior valve 8–10 slits; teeth blunt, pectinated. Eaves spongy. Girdle wide, banded with alternate light and dark, compactly covered with minute smooth, convex scales. Length 36, breadth 20 mill., often less.

Mediterranean and Adriatic Seas; Cape Verde Is.

Chiton squamosus POLI, Test. utr. Sicil. i, t. 3, f. 21, 22 (1791) and of PAYRAUDEAU, COSTA, and PHIL., Enum. Moll. Sicil. i, p. 106, t. 7, f. 3; and of Granger, Moll. France, p. 170, t. 12, f. 16 (1885). Not of Linné.—*Chiton olivaceus* SPENGLER, Skrivter af Naturhistorie-Selskabet, iv, p. 75, t. 6, f. 8*a–c* (1797).—Jeffreys, Rep. Brit. Asso. Adv. Sci. 1873, p. 113.—MONTEROSATO, Enum. e Sinon. p. 17.—BUQ. DAUTZ. et DOLLF., Moll. Mar. du Rouss. i. p. 489, t. 61, f. 4–6, t. 62, f. 4.—LOCARD, Coq. Mar. des Cotes de Fr., p. 232 (1892).—*Ch. sulcatus* RISSO, Hist. Eur. Mérid iv, p. 268.—TIBERI, Bull. della Soc. Malac. Ital. iii, p. 145.—*Chiton siculus* GRAY, Spicil. Zool., p. 5; PHIL., Enum. Moll. Sicil. ii, p. 82.—WEINKAUFF, Conchyl. des Mittelm. ii, p. 408.—REEVE, Conch. Icon., t. 2, f. 5; t. 16, f. 97 (lowest fig.); t. 19, f. 121.—*Glymnoplax siculus*

ROCHEBR., Nouv. Arch. du Mus. 1881, p. 242.—*Chiton polii* DESH. (not Phil.), Exped. Sci. de Morée, iii, p. 132; Lamk. edit. Dh., vii, p. 504.—*C. squammulosus* DOLLFUS, Catal. Palavas, p. 3.

Doubtful synonyms: *Lophyrus siculus forma africana* ROCHEBRUNE Journ. de Conchyl. (3) xxi, p. 42 (1881).—*Chiton striatus* CHIEREGHINI *MS.* BRUSINA Ipsa Chier. Conchyl. p. 44 (1870).—*Ch. estuarii* CHIER., *MS.* BRUS., *l. c.*, p. 45.

This common Mediterranean species is very variable in color, as the figures show, but quite constant in sculpture. The valves are generally very much elevated, like a gothic roof. The prominence of the mucro or beak of the tail-valve, and its central position, are characters showing the strong bond of affinity between *olivaceus* and the Australasian species, and sundering it from the somewhat similarly sculptured West Indian forms. Issel and the authors of *Mollusques Marins du Roussillon* classify the color-forms of this species into two groups: (1) those which are variously marbled and spotted, and (2) those which are unicolored, forming the

Color-var. *unicolor* Issel. Entirely white, tawny or red. It is likely that *C. rubellus* of Nardo was founded upon an individual of the last color.

I regard it as probable that the *Lepidopleurus corallinus* of Risso (Hist. Nat. l'Eur. Mérid. iv, p. 268) was based upon a red example of *C. olivaceus*. Monterosato has suggested that *corallinus* is the same as *rubicundus* Costa+*scytodesma* Scac.,+*freelandi* Fbs.+*pulchellus* Phil.+*philippii* Issel (see Journ. de Conch. 1878, p. 146). This identification seems to me to be quite inadmissible.

Rochebrune describes a 'forma' *Africana* as follows: Allied to *L. siculus*, but differs in having the valves obtusely carinated, the sulci of the central areas very delicate, straight. Length 26 mill.

Promontory of Cape Verde, and Table Bay, Cape of Good Hope.

The reference of this form to the present species is doubtful.

C. AFFINIS Issel. Pl. 35, fig. 93 (enlarged.)

Shell oblong, subcarinated, smooth, painted with various colors; end valves radiately ribbed, the front valve having about 21 ribs, concentrically striated; the other valves having longitudinal arcuate grooves; lateral areas narrow, triangular, transversely trisulcate. Girdle minutely scaly.

Length 18, breadth 11, alt. 6 mill. (*Issel.*)

Gulf of Suez.

Savigny, Descript. de l'Egypte, Gasterop., t. 3, f. 9.—*Chiton affinis* Issel, Malac. Mar Rosso, p. 234 (1869).—*C. siculus* Gray, Cooke, Ann. Mag. N. H. 1885, p. 275.—E. A. Smith, Proc. Zool. Soc. Lond. 1891, p. 392.

I have not seen this species, which is considered by Cooke and Smith to be synonymous with the common Mediterranean *C. siculus* of Gray (*olivaceus* Spengl.). Smith says that it "may be regarded as a strongly marked form of the Mediterranean species. There is also a species found in New Zealand, *C. siculoides* Cpr., *MSS.*=*C. æreus* Reeve, which is also inseparable." As I do not know that Mr. Smith's opinion is founded upon a study of the inside as well as the external characters, I prefer to retain *C. affinis* as a distinct species for the present, although it is certainly closely allied to *C. olivaceus*. Issel gives both figs. 8 and 9 of Savigny's plate as illustrations of his species, but his description applies only to figs. 9. Savigny's figs. 8 represents, in all probability *Callistochiton adenensis* Smith.

C. rubicundus Costa. Pl. 45, figs. 73, 74, 75.

Shell similar in form and color to *Trachydermon ruber*, but much smaller; subelongate, *much elevated*, the valves beaked; dorsal ridge very acute; mucro median, elevated. Entire surface microscopically granulose, *the central areas having spaced, longitudinal parallel sulci*, 6 to 9 on each side; *lateral areas subelevated, smooth.*

Inside having 8–10 slits in the anterior valve, 1 in the central valves, 9 in posterior valve; teeth acute, but all distinctly serrated; eaves moderate; sinus moderate; sutural-plates joined by a small serrated lamina.

Girdle regularly imbricated with large, solid, smooth scales.

Length 8½, breadth 5 mill.; divergence 80°.

Length 6, breadth 2½ mill.

Naples (Philippi); *Dalmatia* (Mus. M'Gill Coll. and Acad. Nat. Sci., Phila.)

Chiton rubicundus O. G. Costa, Catalogo sistematico e ragionato de' Testacei della due Sicilie, p. i, iii, t. 1, f. 2 (Naples, 1829); Fauna di Napoli, Anim. Molli, *Chiton*, p. 8.—*Chiton pulchellus* Philippi, Enum. Moll. Sicil. ii, p. 83, t. 19, f. 14.—*Chiton rubellus* Cpr., *MS.* olim, and *C. ? corallinus* Cpr., *MS.*

Doubtful synonyms: *Ch. freelandi* Forbes, Rep. Aeg. Invert., in Rep. 13th meeting Brit. Asso. Adv. Sci., for 1843, p. 188 (1844).—*C. scytoderma* Scacchi, *C. philippii* Issel.

The prominent features of this little species are its ruddy color, great elevation, like a gothic roof, and the sculpture.

This species is not identical with the *Lepidopleurus corallinus* of Risso, as Monterosato has said. It is impossible for me to believe that Risso would have used the words "avec les élévations latérales bisulquées" if he had been describing *C. rubicundus*. The identification of the learned authority on Mediterranean shells was not founded upon an examination of Risso's type.

C. HAMYI Rochebrune. Pl. 35, figs. 85, 86.

Shell ovate-elongate, carinated, green, *painted longitudinally und regularly with alternating lines of white, blue and buff. Head valve lateral areas and posterior areas of the tail valve sculptured with strong concentric ridges*, which are irregular and as if imbricated; *central areas having 7 strong, wide, obliquely curved ribs, the middle smooth.* Girdle scaly, scales rounded, very shining.

Length 23, width 12 mill. (*Rochebr.*)

Strait of St. Lucie, Cape Verde Is.

Gymnoplax hamyi ROCHEBR., Bull. Soc. Philom., Oct., 1881; Nouv. Arch. du Mus. (2) iv, p. 242, t. 17, f. 13*a*, *c* (1881.)

Allied to *C. concentricus* Reeve, but distinguished by the imbrication and irregularity of the concentric striæ of the end valves and lateral areas, by the width and small number of grooves on the sides of the central areas, and the absence of a mucro on the tail valve. (*Rochebr.*)

The references to the figures of this species and *C. insularis* are transposed in Rochebrune's publication.

C. INSULARIS Rochebrune. Pl. 35, figs. 83, 84.

Shell ovate, elongate, subcarinated, the carina obtuse; olivaceous, sparsely spotted with white; *anterior valve* and posterior part of the *tail valve sculptured with radiating, interrupted, feebly granose ribs;* median valves having the *central areas smooth in the middle, sulcated at the sides, the sulci unequal, lanceolate,* pointed at the ends, *concentrically arranged; lateral areas having branching radiating ribs.* Girdle olive marked with white spots, scaly, the scales minute. (*Rochebr.*) Length 27, breadth 15 mill.

Strait of St. Vincent, Cape Verde Is.

Gymnoplax insularis ROCHEBR., Nouv. Archiv du Mus. (2) iv, p. 243, t. 17, f. 12*a*, *b*. (1881.)

Compare *Ch. olivaceus* Spengl.

C. LYRATUS Sowerby. Pl. 31, figs. 35, 36.

Shell oval, smooth; back subangulated; lateral areas subelevated, smooth; central areas longitudinally lirate at the sides; girdle broad, minutely scaly. Length 37, breadth 15 mill. (*Sowb.*)

This shell is so thin as to be nearly transparent; it is smooth, rather angulated in the center, the lateral areas smooth, slightly elevated, the central areas marked with faint longitudinal ribs. The margin is covered with regular, minute scales. The general color is drab, variegated with brownish concentric lines at the sides and reddish-brown dorsal bands on some of the valves. (*Sowb.*)

Habitat unknown.

Chiton lyratus SOWB. in Charlesworth's Mag. of Nat. Hist. 1840, p. 293; Conchol. Illustr., f. 126.—REEVE, Conch. Icon., f. 110.

This shell should be compared with *canariensis* Orb. and *dissimilis* Reeve.

Carpenter has described a *C. semilævis* in *MS.* from Cumingian specimens of unknown locality. It will probably prove to be a form of the above species.

Reeve reports *C. lyratus* from Prince Island, West Africa, under stones.

C. DISSIMILIS Reeve. Pl. 37, fig. 11.

Shell oblong-ovate; terminal valves and lateral areas longitudinally grooved, smooth in the middle; variegated with reddish-brown; ligament granosely coriaceous, tessellated. Approximating in some measure to the *C. tulipa*. (*Reeve.*)

Habitat unknown.

C. dissimilis REEVE, Conch. Icon., t. 25, f. 170 (May, 1847.)

Reeve s description does not correspond very well with his figure; and the species will probably prove to be the same as *C. canariensis* Orb.

Carpenter notes that in Reeve's type specimen the whole surface is conspicuously quincuncially granulated. The anterior valve has 9, central 1, posterior valve 13 slits; teeth sharply pectinated. It measures, length 18, breadth 9 mill.; divergence 90°.

C. CANARIENSIS d'Orbigny. Pl. 34, figs. 77, 78, 79.

Shell oblong; carina smooth, central areas of the valves longitudinally sulcated, lateral areas smooth; ends smooth; margin granulate-scaly. Length 24, width 12 mill. (*Orb.*)

The shell is oblong, a little carinated; the intermediate valves are *smooth at the carina, marked on each side with strong ribs* separated by deep grooves; the *lateral areas are entirely smooth*, as well as the end valves. The girdle is wide, extensible, covered with little oblong, smooth and polished scales, largest in the middle of its width.

The colors are very variable; sometimes marbled with black and brown spots on a white ground, sometimes with some valves quite black or green, the others spotted. The girdle is radiated with black, gray and white. (*Orb.*)

Canary Is. (Webb and Berthelot.)

C. canariensis ORB., in Webb & Berth., Hist. Nat. des Iles Canaries, Moll., p. 99, t. 7, f. 16–19.—*Chiton* (*Lophurus*) *canariensis*, SHUTTLW., Bern. Mittheil. 1853, p. 81.

Allied to *C. olivaceus*, but differs in having the lateral areas and end valves smooth. The interior, according to Shuttleworth, is green, with spots of rose and purple. This species should be compared with *C. lyratus* Sowb.

C. TULIPA Quoy & Gaimard. Pl. 31, figs. 43–49.

Shell oval-oblong, elevated, acutely carinated, the side-slopes nearly straight. *Surface smooth and polished throughout.* Ground-color buff or whitish, suffused and closely mottled all over with reddish-chestnut, fawn, or purple-brown; usually longitudinally streaked on the central areas, zigzagged or tessellated on the end valves, and articulated on the diagonal lines with the darker color. Sometimes parts of some valves, or several whole valves are of a uniform dark brown color (figs. 43, 45.)

The central areas are smooth except for slight growth-lines and a microscopic granulation which covers the whole surface. *Lateral areas well raised*, flat, rarely with slight radii, smooth. In the excavation at the diagonal line a lens shows a few very short longitudinal grooves, in some specimens. Tail valve elevated, *with central umbo.*

Interior very light blue-green, each valve rayed with brown at the beaks. Anterior valves having 8, central valves 1, posterior valves 12 slits; teeth pectinated. Eaves short, spongy, grooved along the teeth. Sinus narrow, denticulate.

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Girdle solid, closely covered with smooth, convex scales.

Length 43, breadth 25 mill.; divergence 105°.

Length 38, breadth 27 mill.; divergence 100°.

Length 33, breadth 24 mill.; divergence 112°.

Cape of Good Hope.

Chiton tulipa QUOY & GAIMARD, Voy. de l'Astrol. Zool., iii, p. 389, t. 74, f. 35–36 (1834).—KRAUSS, Die Südafric. Moll., p. 37.—*C. cymbiola* SOWERBY, Charlesworth's Mag. of Nat. Hist. 1840, p. 292; Conch. Illustr., f. 45, and var., f. 85, 86.—REEVE, Conch. Icon., t. 3, f. 18.

? *C. politus* SPENGLER, Skrivter af Naturhist.-Selskabet, iv, p. 89, 1797.

A smooth, polished species, excessively variable in color and pattern. The short traces of grooves at the diagonal line are rarely visible without a lens, and are completely obsolete in many specimens. The smooth surface and unusual coloring are the more striking characters of the species; but the strongly raised lateral areas and the central mucro at once separate it from *C. lævigatus*, *marmoratus*, etc.

C. RUSTICUS Deshayes. Pl. 31, figs. 32, 33, 34.

Shell ovate-oblong, depressed, the jugum rounded; very dark green, much paler beneath.

Entire surface quincuncially granulose. Central areas with no other sculpture, but *at the diagonal line there are on each side* 10–15 *very short but deep grooves.* Lateral areas swollen, and having *a few indistinct, obsolete swelling ribs*, or rather, obsolete knobs irregularly coalescing into indistinct ribs; blotched with paler. End valves similarly sculptured and blotched, beak of the tail valve in front of the middle, the slope behind it a trifle concave.

Interior: anterior valve having 9, central valves 1, posterior valve 12 slits; teeth pectinated; eaves short; sinus moderate, with about 13 teeth.

Girdle dark olive, like the valves; covered with very large stout scales.

Length 24, breadth 15, alt. 6 mill.

Length 20, breadth 13 mill.; divergence 115°.

Réunion and Mauritius.

C. rusticus Dh., Moll. Réun., p. 39, t. 6, f. 1–3.—Cpr., *MS.* ii, p. 25.—*C.* (*Lepidopleurus*) *rusticus* Mts. in Möbius' Reise nach Mauritius, p. 300.

This species has considerable resemblance to *C. nigrovirens*, but the lateral areas and end valves are less strongly sculptured and the longitudinal riblets are lacking on the central areas except at the diagonal lines. The above description is from Carpenter's *MS.*

C. angusticostatus Quoy & Gaimard. Pl. 31, figs. 37, 38.

Shell ovate, wide, little elevated, depressed behind by the prominence of the anterior valve. The third to the seventh valves are excessively narrow, arcuated behind, with a little median projection, which contributes to form a dorsal carina. The last valve is the largest of all, nearly orbicular; the second valve is next in size, the intermediate valves being about equal. Sutural plates narrow, separated by a wide, flat, sinus; insertion-plates denticulate. The end valves have striated teeth. The entire interior is a pretty green; and this we suppose to be the color of the outside, but it is eroded. We think it is striated like our *C. viridis*. The girdle is scaly, the scales oval. Length 22, width 16, alt. 8 mill.

Isle of France.

C. angusticostatus Q. & G., Voy. Astrol. iii, p. 398, t. 73, f. 4, 4'.

The entire substance of Quoy's description is rather freely translated in the above paragraph. It is very likely that this is merely a greatly worn specimen of *C. pellisserpentis* Q. & G.

C. nigrovirens Blainville. Pl. 31, figs. 41, 42 (enlarged.)

Shell ovate, moderately elevated, the dorsal ridge obtuse; blackish. Mucro in front of the middle, little raised, the slope behind it straight.

Valves obtusely beaked; entire surface minutely quincuncially granulated; jugal area smooth, often eroded; central areas having about 30 delicate lirulæ on each side, parallel to the dorsal ridge, sometimes eroded; lateral areas moderately raised, having 6 to 8 delicate granulose riblets, the intervals flat.

Interior: anterior valve having 12, central valves 1, posterior valve 14 slits; teeth short, obtuse, coarsely pectinated; eaves small; sinus wide, flat, 12-toothed.

Girdle covered with solid, smooth, large and rounded imbricating scales. Length 17½, breadth 10 mill.; divergence 117°.

Cape of Good Hope.

Chiton nigrovirens BLAINVILLE Dict. Sci. Nat. xxxvi, p. 538 (1825).—HADDON, Challenger, Polyplac., p. 22.—*C. capensis* GRAY, Spicil. Zool., p. 5 (1828).—HANLEY, in Wood, Index Test. Suppl. t. 1, f. 11.—REEVE, Conch. Icon., t. 22, f. 151.—KRAUSS, Die Südafric Moll., p. 37.

C. TENUISTRIATUS Sowerby. Pl. 38, figs. 27, 28.

Shell oval, carinated, the back elevated; valves all over very finely radially striated; girdle scaly.

Length 25, width 15 mill. (*Sowb.*)

A neat little shell of a dark olive-green color, oval, elevated, nearly smooth in appearance, but finely striated; margin lighter green than the rest of the shell; inside bluish-green. (*Sowb.*)

Habitat unknown (Mus. Stainforth.)

C. tenuistriatus SOWB., in Mag. Nat. Hist. 1840, p. 291; Conch. Illustr., f. 135, 135.

This is apparently a typical *Chiton*, closely allied to *quoyi* or *nigrovirens*, but it seems to be more elevated than either.

C. MAURITIANUS Quoy & Gaimard. Pl. 31, figs. 39, 40.

Shell small, oval, elongated, the valves elevated, carinated, transversely finely striated and having lateral areas over which the striæ pass. It is a very dark green, lighter at the ridge, and at the edge of the girdle, which is covered with fine, close, rounded scales, and marked with 18 brown bands. Branchial leaflets about 38 on each side. Length 18, breadth 10, alt. 6 mill.

Mauritius.

C. mauritianus Q. & G., Voy. Astrol. iii, p. 397, t. 73, f. 1–3.—*Lepidopleurus mauritianus* MARTENS, in Möbius' Reise nach Mauritius, p. 300.

Known only by the original description, which is far from being satisfactory. The interior has not been described. It is a more carinated species than *C. quoyi*, and the striation is in a different direction; the girdle also being banded with brown.

Section SCLEROCHITON Carpenter, 1892.

Sclerochiton CPR., *MS.*, in Dall, Proc. U. S. Nat. Mus. 1881, p. 284, 287, 289 (no type mentioned.)

Teeth of the tail valve turned forward, blunt and pectinated; sinus smooth, not denticulate; scales of girdle solid, striated, separated.

This section or subgenus represents a further development of the Acanthopleuroid characters which some Australasian species of the restricted genus *Chiton* assume. In *Ch. pellisserpentis*, for example, the mucro is median, the posterior teeth tend forward somewhat, the sinus is smooth or only very obsoletely denticulate, and the girdle-scales are striated and rather separated. In *Sclerochiton* the mucro is slightly more posterior, the teeth slightly more tilted forward; the sinus is smooth, and the girdle scales still more separated. *Ch. pellisserpentis* could be placed almost as well in *Sclerochiton* as in *Chiton s. s.*; the necessity of reducing *Sclerochiton* to the rank of a section under *Chiton* will therefore be apparent. The girdle-scales bear a certain resemblance to those of *Enoplochiton*, but this is a purely accidental similarity, dependent upon their separation on the surface of the girdle.

C. MILES Carpenter, n. sp. Pl. 46, figs. 1, 2, 3, 4, 5.

Shell solid, rugose, oval, depressed, generally eroded; dorsal ridge rounded, hardly defined; mucro behind the middle, nearly flat; apices of the valves prominent, obtuse. Ashen, spotted with black-brown. Central areas transversely pretty regularly rugulose, the wrinkles appressed; lateral areas hardly elevated, moderately well defined, conspicuously rugose, rugæ subradiating, granose; the end valves similarly sculptured.

Interior having the anterior valve with about 11, central 1, posterior valve obscurely 9–11, slits. Teeth of posterior valves directed forward, strongly callosed inside above the slits, sulcate outside; the rest of the valves having the teeth sulcate outside and pectinated at the margins. Eaves moderate, solid, deeply grooved. Sinus deep, wide, wavy, smooth; sutural laminæ united.

Girdle (pl. 46, fig. 1.) maculated, ornamented with large, solid, more or less separated scales which are striated outside; no hairs. (*Cpr.*). Length 30, breadth 17½ mill.; divergence 130°.

Torres Straits (Mus. Cuming, no. 42.)

A variety is described as being a little narrower, and blackish, hardly maculated.

Section RADSIA Gray.

Radsia GRAY, P. Z. S. 1847, p. 126. Type *Ch. barnesii.*

Girdle and shell like *Chiton*, except that the insertion-plates of the intermediate valves have two or several slits.

Carpenter's opinion of the small importance of the character upon which this group is founded, is fully supported by the material studied by myself. He writes as follows: "The bi- or tri-slitting of the laminæ appears to me a character of very secondary importance, as being merely numerical, not structural, and as being very variable even in the same specimen. In one specimen of Dr. Gray's type which I received from Mr. Cuming, *only one valve had two slits on each side;* most of the other valves had one only; sometimes a second slit was seen on one side. For such a specimen it would have been as useless to establish a genus as for *Ch. virgulatus*, or for *C. bowenii* in which Dr. Gray found the same abnormality (*vide* P. Z. S. 1847, p. 127). Another specimen of *C. barnesii* had the valves either with one slit or with two slits on each side, or with one on one side and two or three on the other. Under these circumstances I cannot regard the number of slits as a generic character."

Compare alse the notes under *C. virgulatus.*

Key to species of Radsia.

a. Surface smooth, *goodalli.*

aa. Surface sculptured with riblets.

b. Ribs strong and coarse; color black-olive, uniform, *sulcatus.*

bb. Riblets fine; color variegated.

c. Ribets of central areas nearly obsolete; of lateral areas granose, *barnesii.*

cc. Riblets of central areas fine, distinct; shell olive mottled with dark, *virgulatus.*

C. BARNESII Gray. Pl. 29, figs. 10, 11, 12.

Shell oval, *depressed*, scarcely carinated. Black-brown, yellowish toward the ridge where each valve generally has a dark triangular spot, and having a buff-white longitudinal stripe on each side; girdle green.

Lateral areas raised, *sculptured with about* 6 *irregular, uneven, rather nodulous radiating ribs. Central areas sculptured with fine longitudinal riblets, subobsolete toward the dorsal ridge,* and somewhat latticed by growth-lines. End valves having radiating nodulous ribs; *umbo of the posterior valve very near the front margin.*

Interior whitish; sinus finely and rather unevenly toothed. Anterior valve having 15–16, central valves 2, (occasionally 1 on

one side, 2 on the other), posterior valve 18–19 slits. Teeth blunt, pectinated; eaves narrow, spongy.

Girdle covered with shining, convex, minutely striated scales.

Coquimbo, Chili.

Chiton barnesii GRAY, Spicil. Zool., p. 5, t. 6, f. 22.—SOWB. in Moll. Beechey's Voy., p. 149, t. 41, f. 10; Conchol. Illustr., f. 2.—REEVE, Conch. Icon., t. 1, f. 1; t. 21, f. 137.

Entirely different from the other species of *Radsia* in form and sculpture. The riblets upon the central areas are very fine and their interspaces shallow. Occasionally a specimen occurs having some of the valves with a single slit one side.

C. GOODALLII Broderip. Pl. 29, fig. 9; pl. 28, figs. 5–8.

Shell very *large*, oval, moderately elevated, carinated, the side-slopes nearly straight or rather convex. *Surface nearly smooth.* Color blackish, olive-black or brown-black, generally showing an obscure olive-green stripe on each side of the keel.

The lateral areas are a little raised, separated by an obtuse ridge from the central areas, and in most specimens they are *somewhat terraced by concentric marks of growth-arrest. There is no other sculpture on either central or lateral areas* except an extremely minute and even granulation over the whole surface. *The umbo of the posterior valves is unusually near the front margin.*

Interior white, each valve having a pair of posterior rays and a central spot of brown. Sutural plates broad, sinus rather shallow having about 8 teeth. Anterior valve having 25–26, central valves 2–3, posterior valve 26–28 slits; teeth stout, blunt, deeply pectinated; eaves very spongy.

Girdle covered with coarse flattened-convex scales.

Length 110, breadth 70 mill.

Galapagos Is.

Chiton goodallii BROD., P. Z. S. 1832, p. 25.—*C. godallii* SOWB., Conch. Ill., f. 34, 40.—*C. goodalli* REEVE, Conch. Icon., f. 8.—*Radsia goodalli* CPR., *MS.*

This very large smooth species is quite unlike any other.

C. SULCATUS Sowerby. Pl. 28, figs. 1, 2, 3, 4.

Shell oval or oblong, moderately elevated, carinated, the side-slopes nearly straight; of a *uniform olive-black*, or having the lateral areas obscurely purple-black.

Lateral areas *very strongly radiately ribbed* and grooved, the posterior rib of each valve broad and crenulated, the other ribs unequal, varying in number, usually split toward the outer edge of the shell. Central areas sculptured with numerous strong but smaller riblets, which near the dorsal ridge converge forward, but on the pleura they diverge strongly. End valves having strong radiating ribs, which split toward the periphery. Umbo of posterior valve prominent, in front of the middle.

Interior blue-green; sutural plates broad; sinus rather deep and square, finely toothed. Anterior valve having 23–26, central valves 2–3, posterior valve 18–20 slits; teeth stout, blunt, finely and strongly pectinated. Eaves coarsely spongy.

Girdle covered with coarse convex scales, larger toward the periphery. Length 95, breadth 55 mill.

Galapagos Is.

Chiton sulcatus Wood, Gen. Conch., p. 16, t. 3, f. 1.—Sowb., Conch. Illustr., f. 12.—Reeve, Conch. Icon., f. 15.—*Radsia sulcata* Cpr., *MS.*

This is one of the most strongly sculptured of all Chitons, and is correspondingly easy to recognize. There are usually two slits in each side insertion-plate, but the second valve occasionally has as many as four.

C. (*Radsia*) *cærulescens* Shuttleworth, Diagn. n. Moll., no. 4, in Bern. Mittheil. 1853, p. 65. No description of this species has been published. It is said to be from California. Possibly founded on a *Ch. virgulatus*, q. v.

Genus XIII. EUDOXOCHITON Shuttleworth, 1853.

Eudoxochiton Shuttlw., Bern. Mittheil. 1853, p. 67, type *A. nobilis* Gray.—*Acanthopleura* sect. * * †, Gray, P. Z. S. 1847, p. 68, *non* Guilding.—*Maugeria* sect. †, Gray, Guide, p. 184, 1857.—*Chætopleura* Ads. *et al.*, *non* Shuttlw.

Valves entirely exposed, smoothish, lacking eyes; mucro flat; the sutural plates broad and connected across the sinus; insertion-plates of all valves blunt, closely and deeply cleft, the median valves with 3 or 4, end valves with many short slits. Girdle leathery, setose. Gills extending the entire length of the foot.

The valves, when eroded, are seen under the lens to be densely, evenly and regularly punctured all over. The interior is white, and

of a dense, porcellanous texture. The laciniated insertion-plates, cut into many short teeth, combined with the harshly setose girdle and continuous sutural-plates, are the most striking generic characters.

From *Acanthopleura* and *Maugeria*, groups to which some authors have referred the type of this genus, *Eudoxochiton* is sundered by the lack of eyes in the valves, the multiplicity of slits, depressed mucro, etc.

Besides the following, *Ch. linter* (Chem.) Reeve may belong to this genus, but its generic characters are entirely unknown. See appendix.

E. NOBILIS Gray. Pl. 46, figs. 88–95.

Shell oblong, *elevated*, the valves well arched, and very obtusely angular on the dorsal ridge, side-slopes convex. Color uniform dark brown, a little mottled toward the beaks, and marked with scarlet there; girdle rusty-brown.

Valves broadly A-shaped, not beaked, the lateral areas moderately raised, smooth except for the microscopic granulation and a few excessively indistinct radii. Central areas having indistinct growth-lines. Posterior valve (figs. 92, 93, 94) elevated in front, the mucro flat, central; posterior margin gently emarginate behind.

Interior porcelain-white, immaculate; smooth and poreless. Sutural plates squared, continuous across the sinus, which is indicated by a median bay or notch. Insertion-plates having broad, blunt edges, irregularly and deeply pectinated, and having in the head-valve 30, median valves 3–4, tail-valve 24–25 short slits. Eaves very narrow, deeply grooved along the teeth and slightly spongy there.

Girdle (fig. 95) leathery, rust-colored, bearing short rigid *black* spinelets. Length 60, breadth 35 mill.; divergence 100°–110°.

Auckland, Cooks' Strait; Martin's Bay, New Zealand.

Acanthopleura nobilis GRAY, in Dieffenbach's New Zealand, ii, p 245 (1843).—*Chiton* (*Eudoxochiton*) *nobilis* Gray, SHUTTLW., Bern. Mittheil. 1853, p. 67.—*Chiton* (*Chætopleura*) *nobilis* Gray, SMITH, Zool. Erebus and Terror, p. 4, t. 1, f. 8 (1874).—HUTTON, Man. N. Z. Moll., p. 115 (1880.)

This species differs from the following in its more elongated and much more elevated contour, and in the stronger valves. The

seventh valve is represented in figs. 89, 90; and a square millimeter of the girdle is indicated in fig. 95.

E. HUTTONI Pilsbry, n. sp. Pl. 46, figs. 96–100.

Shell oval, *depressed*, with convex side-slopes. Color dark brown, the girdle greenish-brown. Valves broadly A-shaped, not beaked, rounded at the ends; the lateral areas well raised. Entire surface smooth except for a microscopic punctulation and slight growth-lines. Posterior valve (figs. 98, 99) depressed, the mucro plane, central; posterior margin hardly marginate.

Interior white, smooth. Sutural plates continuous across the sinus which is indicated by a shallow wave or bay. Insertion-plates blunt, deeply pectinated, the anterior valve having 17, central 3, posterior 19 short slits. Eaves very narrow and grooved along the teeth.

Girdle leathery, bearing numerous short, rigid, dark brown spinelets. Length 50, breadth 34 mill.; divergence 135°–140°.

New Zealand.

This species is closely allied to *E. nobilis*, from which it differs in the proportions of the valves, depressed form, fewer slits, etc. The seventh valve is represented in figs. 96, 100. The specimen illustrated was sent me by Professor Hutton.

Genus XIV. TONICIA Gray, 1847.

Tonicia GRAY, P. Z. S. 1847, p. 65, 67; Guide Syst. Dist. Moll. B. M., p. 185 (1857), and of authors.—Probably *Tonichia* GRAY, Synops. Contents B. M., 42d edit., p. 153, 1840 (name only.)

Generic characters.—Valves external, all having pectinated insertion-teeth; sinus denticulate; lateral areas and end valves bearing radiating rows or bands of eye-dots. Girdle leathery, naked or sparsely hairy. Gills extending the whole length of the foot. Type *C. elegans* Frembly.

Besides the fundamental characters above recounted, the species of this genus mostly agree in having the valves smoothish, the second valve notably larger than the following five, and often differently sculptured on the ridge; the sculpture is generally fine or minute, the colors much variegated or uniform black-brown, and the eaves are hardly spongy.

From *Chætopleura* and *Tonicella* this genus is very strongly differentiated by the presence of eyes, and also by the more distinctly

pectinated insertion-plates. The genus *Onithochiton* has similar smooth valves, but the posterior valve lacks slits and teeth of insertion.

The species of *Tonicia* inhabit mainly the shores of the southern and tropical Pacific, being found from Middle America to Cape Horn, and from the Philippines to Australia and New Zealand. They may be grouped thus:

A. Valves not immersed or separated, imbricating, section *Tonicia*.
   1. Species of West America.
   2. Species of the West Indies.
   3. Species of New Zealand, Australia, Red Sea, Philippines.

B. Valves partly separated, the girdle encroaching on them at the sutures, section *Fannettia*.

Section *Tonicia s. str.*

1. *Species of West American shores.*

T. CRENULATA Sowerby. Pl. 45, figs. 69, 70, 71, 72.

Shell oblong-ovate, slightly more narrowed in front, moderately raised, the back carinated. Ground-color buff or slightly rose-tinged, having oblique dark olive irregular stripes, often marked on some valves with rich brown; apices of valves pink when eroded.

The *lateral areas are raised and well-defined*, and except the posterior third or fourth, *are studded closely with black eyes;* the *suture is prominently and coarsely crenulated*, and there are some irregular radiating rows of granules on the back part of the areas, and sometimes a row or two dividing the eye tract. *Central areas having a smooth keel in the middle, bounded on each valve by a* V *formed by two low divergent waves, crossed by convergent riblets;* pleura or sides sculptured with longitudinal-diverging rugæ or ribs. Anterior valve high, with radiating rows of weak granules alternating with rays crowded with eyes. Tail valve with slightly posterior, elevated mucro.

Interior white, with a large red tract in each of the median valves. Slits in anterior valve 8, central 1, posterior 14; teeth obtuse and short in the posterior, acute and longer in the anterior valves, sulcate

outside and at edge. Sinus square, denticulate; sutural-plates and insertion-plates white.

Girdle leathery, thin, yellowish-green, naked.

Length 34, breadth 20 mill.

Length 50, breadth 33 mill.; divergence 115°.

Pearl Island, Bay of Panama (Cuming, *et al*); *Mazatlan* (Reigen.)

Chiton crenulatus Brod., P. Z. S. 1832, p. 27.—Sowerby, Conch. Illustr., f. 43.—Reeve, Conch. Icon., no. 29, t. 6, f. 39 (error for 29). "*? Tonicia*" *forbesii* Cpr., Mazatlan Catal., p. 193 (1856.)

This species is readily distinguished from the other West American forms by the greater width of the lateral bands of eyes, the crenulated sutures, and the beautiful sculpture of the central areas. The second valve is not so prominent as in most species of *Tonicia*, and it is sculptured like the other intermediate valves.

T. elegans Frembly. Pl. 41, figs. 22, 23, 24; pl. 42, figs. 31, 32, 33, 34, 35.

Shell elliptical-oblong, not much elevated, the dorsal ridge rounded, side-slopes straightened. Color umber-brown at the sides, becoming chestnut in the middle, delicately and peculiarly speckled and blotched and streaked with buff or buff-white.

Lateral areas hardly raised, but separated from the central areas by an *obtuse diagonal ridge bearing a series of low tubercles*, sometimes subobsolete; *sculptured with subradiating rows of small granules*, and showing a band of irregularly placed black eyes on the forward part. Central area of second valve having in the middle, a keel or a group of liræ; *central areas of the other valves having a narrow smooth dorsal band with several longitudinal furrows on each side of it;* and at the sides there are longitudinal diverging delicate rows of granules. End valves radially subgranulate, and crowded with eye-spots subradially arranged. Mucro in front of the middle, moderately elevated.

Interior porcelain white, with a spot or "V" of red-brown under the beak of each valve. Sinus flat, distinctly but finely denticulate. Slits short, in the anterior valve 8, in the central 1, in the posterior valve 9–12; teeth blunt, long and very finely, deeply pectinated outside; slit-rays regularly puncticulate.

Girdle naked, leathery, of a chestnut-yellow color.

Length 48, breadth 32 mill.; divergence 125°.

Callao to Valparaiso.

Chiton elegans FREMBLY, Zool. Journ. iii, p. 203, suppl., pl. 17, f. 6.—SOWB., Conch. Illustr., no. 75.—REEVE, Conch. Icon., t. 4, f. 19. —*C. sparsus* SOWB., Conch. Illustr., f. 73, 74 (young.)

The type species of *Tonicia*. The sculpture is well shown in fig. 22; the color-pattern in the figure between 22 and 24.

Subspecies CHILENSIS Frembly. Pl. 41, figs. 19, 20.

Shell rather heavier and thicker than *T. elegans*, with thicker girdle. *Color a uniform dark chocolate brown, except near the beaks where there is a large or small area the shape of the valve which is light delicately mottled with reddish;* girdle dark brown, wide at the sides, narrow at the ends.

The diagonal line is surmounted by a series of small tubercles; lateral areas showing fewer and less conspicuous eye-spots than *T. elegans*, and otherwise *nearly smooth, the granulation being obsolete;* central areas striated on each side of a median smooth band, and more or less (variously) roughened at the sides; second valve subcarinate, striated in the middle. End valves radially, sparsely granulate and dotted with eyes, the umbo of the tail valve obtuse, conspicuous, elevated, a little in front of the middle.

Interior white, marked with reddish under the beaks. Sinus toothed. Sutural plates broad, *especially at the outer-anterior portion.* Anterior valve having 7, central valves 1, posterior valve 8 slits; *teeth very thick and blunt*, strongly, closely pectinated.

Girdle leathery, naked, rather thick.

Length 38, breadth 28 mill.; divergence 130°.

Length 68, breadth 43 mill.

Valparaiso, under stones.

C. chilensis FREMB., Zool. Journ. iii, p. 204, suppl., pl. 17, f. 8.—REEVE, Conch. Icon., t. 3, f. 17.—*Tonicia chilensis* ROCHEBRUNE, Nouv. Arch. du Mus. 1881, p. 240 (Reported from the Canaries, on the authority of specimens so labelled in the Paris Museum, but undoubtedly false.)

This form is very closely allied to *T. elegans*, differing mainly in the (*a*) dissimilar coloration, (*b*) more numerous striæ on each side of the median smooth band, (*c*) generally obsolete granulation of the lateral areas, (*d*) thicker insertion-teeth, and in the thicker girdle; a still better distinction is in the tail-valve, which in *chilensis* has a more prominent umbo, nearer the center than in *elegans*, and the area in front of the umbo is striated, whilst in *elegans* it is smooth. All

of these differences however, do not avail to name specimens in which various characters of *elegans* are combined with other characters of *chilensis;* so that while when typically developed the forms may readily be separated, it is, I believe, impossible to classify occasional synthetic specimens. I have therefore considered *chilensis* a phase or variety of *elegans.*

Subspecies LINEOLATA Frembly. Pl. 41, figs. 25, 26, 27.

Shell oblong, moderately raised, the ridge rather rounded. Surface smoothish. *Ground color light fawn or fleshy, each valve closely and finely lineolate with chestnut,* the lines concentric to the umbones; fifth valve marked with brown at the ridge, and often some of the other valves are marked with dark brown or are entirely of that color.

Lateral areas closely, finely granulated, and having two or three rows of eyes extending down near the low, smooth diagonal. *Central areas smooth except for a group of engraved grooves on each side of the smooth narrow dorsal band.* Second valve either smooth or having a median carina. End valves granulate toward the periphery, closely dotted with eyes in irregularly radiating rows. Umbo of tail valve anterior, the space in front of it smooth.

Inside white, each valve marked with reddish under the beaks. Sinus delicately denticulate. Anterior valve having 8–9, central 1, posterior valve 9–10 slits; teeth blunt, pectinated.

Girdle leathery, nude, yellowish-brown.

Length 25, breadth 15 mill.; divergence 110°.

Length 40, breadth 23 mill.

Valparaiso, Chili.

Chiton lineolatus FREMBLY, Zool. Journ. iii, p. 204, suppl., pl. 17, f. 7 (Good).—SOWERBY, Conch. Illustr. (as syn. of *elegans*), f. 154. —REEVE, Conch. Icon., t. 7, f. 34.—*Tonicia lineolatus* CPR.—? *Chiton bruguieri* Pot. & Mich. Galerie, i, p. 534 (1838.)

The distinguishing characters of typical *lineolatus* are the lack of larger tubercles along the diagonal ridge, and the fine concentric line-painting. The characters of both sculpture and color-pattern however, are in some specimens inextricably united with these of *T. elegans,* of which species I am therefore compelled to consider this a variety.

Many specimens show several valves of uniform black-brown; others are blotched on many valves with the same. The species

somewhat resembles *Tonicella lineata* Wood (see p. 42, pl. 11, figs. 25–28), but differs sufficiently in sculpture and the possession of black eye-pits, as well as in the entirely different insertion-plates. *T. swainsoni* resembles *lineolata* in color-pattern, but it differs entirely in having the entire central areas longitudinally, and the lateral areas and end valves radially costulate.

T. FASTIGIATA (Gray) Sowerby. Pl. 41, fig. 21; pl. 42, figs. 36, 37, 38, 39.

Shell oblong, moderately elevated, subcarinated; the side-slopes nearly straight; surface smoothish. Color *olive-brown*, sometimes whitish, *having indistinct concentric darker streaks;* rarely unicolored black-brown.

Lateral areas hardly raised, indistinctly separated from the central areas by a smooth, low or obsolete diagonal ridge. *Entire surface of lateral and central areas covered with a microscopic granulation*, the granules sometimes coalescing into short wrinkles in front of the diagonal at the sides. *Dorsal ridge having a very narrow smooth band in the middle, on each side of which there are several deeply engraved longitudinal grooves.* Second valve either smooth or having a group of striæ in the middle. End valves showing numerous rays of eyes; the mucro of the posterior valve prominent, in front of the middle.

Interior white, marked under the apex or suffused throughout the jugal tract with reddish. Sinus toothed. Anterior valve having 7, central 1, posterior valve 10 slits; teeth rather thin, crenulated outside and at the edge.

Girdle leathery, nude, dark brown.

Length 54, breadth 34 mill.; divergence 110°.

Length 48, breadth 26 mill.; divergence 110°.

Sts. of Magellan.

C. fastigiatus GRAY, in SOWB., Conchol. Illustr., f. 11, 35.—REEVE, Conch. Icon., f. 26.—SMITH, P. Z. S. 1881, p. 35.

? *Chiton chiloensis* SOWB., P. Z. S. 1832, p. 58; Conch. Ill. (as syn. of *elegans*), f. 13*, 10, 29, 30.—REEVE, Conch. Icon., t. 3, f. 14.

The main distinguishing characters of this species are its even fine granulation, lack of tubercles on the low diagonal ridge, few engraved grooves on each side of the smooth narrow dorsal band, and the obscure concentrically streaked style of coloration.

I do not know whether the *C. chiloensis* of Sowerby belongs to this species or to *C. elegans*. It is represented on pl. 42, fig. 40.

T. GRANIFERA Sowerby. Pl. 43, figs. 44, 45.

Shell ovate, chestnut varied with white and black; dorsum elevated; front valve radially granose; lateral areas and posterior area of posterior valve subradiately graniferous; central areas longitudinally granose-lineate, marginal ligament smooth.

Length 25, breadth 15 mill. (*Sowb.*)

Concepcion, Chili; on Mytilus in 9 fms. (Cuming.)

C. graniferus SOWB., P. Z. S. 1832, p. 104 (Conch. Ill., f. 8 ?).—REEVE, Conch. Icon., t. 15, f. 86.—*Tonicia granifera* CPR., *MS.*

Evidently closely allied to *T. elegans*, having much the same sculpture.

T. GRAYI Sowerby. Pl. 43, figs. 46, 47.

Shell oblong, pale, varied with brown and rufous; *anterior valve, lateral areas and tail valve radially granose-striate;* anterior margins of lateral areas elevated, posterior margins [*sutures*] *crenulated. Central areas obliquely longitudinally granulose-striate; third to seventh valves longitudinally bisulcate in the middle.* Marginal ligament smooth. Length 30, breadth 17½ mill. (*Sowb.*)

Island of St. Lawrence, Bay of Callao, Peru, on shells in 17 fms. (Cuming.)

Chiton grayii SOWB., P. Z. S. 1832, p. 57; Conch. Illustr. f. 8.—REEVE, Conch. Icon., t. 17, f. 105.—*Tonicia grayi* CPR., *MS.*

This form is evidently closely allied to *T. elegans*, etc. The italics of Sowerby's description translated above are my own.

Carpenter thus describes the type specimens: Jugular areas with deep grooves on each side of the central smooth rib, but both grooves and rib are evanescent on the second valve. Central areas with a second set of granules parallel to the diagonal and more or less continued into faint riblets, somewhat diverging from the more prominent apices. Lateral areas with a very decided row of rugose granulations along the diagonal, inside of which is a smooth space crowded with metallic dots [eyes]; then two or more rows of very rough irregular granules, ending in sharply crenate sutures. End valves with about eleven obsolete riblets, irregularly granose, with rows of metallic dots between each. Mucro in front of the middle, swollen, but the slope behind it *concave*. Anterior valve having 8

central 1, posterior valve 14 slits; teeth very sharp, pectinated. Sinus flat moderately deep and broad, with up to 16 teeth.

Length 30, breadth 17 mill.; divergence 105°.

T. ATRATA Sowerby. Pl. 41, figs. 28, 29, 30.

Shell oval-oblong, smooth, subcarinated; valves nearly straight, subrostrate; lateral areas inconspicuous; margin [girdle] smooth.

Length 25, breadth 12½ mill. (*Sowb.*)

The smooth, narrow, slightly angulated species above described is of a blackish-brown color; the lateral areas are not distinctly marked except by rays of lighter color in some specimens on them, and on the terminal valves. (*Sowb.*)

Falkland Is. (Sowb.); *Orange Harbor* (U. S. Ex. Exped.)

Chiton atrata SOWB. in Charlesworth's Magazine of Nat. Hist. 1840, p. 294; Conch. Illustr., f. 57, 58.—REEVE, Conch. Icon., t. 17, f. 103.—GOULD, U. S. Expl. Exped., p. 329, f. 415.—*Tonicia atrata* H. & A. ADS., Gen. Rec. Moll. i, p. 474.—ROCHEBRUNE, Polyplac. Cap Horn, p. 138.—*T. bætica* CPR., *MS. olim.*

I have not seen this species. Carpenter writes: Mucro more or less elevated, tumid behind. Inside having 8 slits in the anterior, 1 in the middle and 12 in the posterior valve; teeth acute, outside and at the edge sulcate, scarcely pectinated; sinus moderate, flat, with 13–20 denticles.

Hutton reports this species from Macquarie Island, N. Z., but says: "Our species agrees very well with Reeve's figure, but not with his description. The anterior terminal area is distantly radiately ribbed, and the lateral areas are sometimes defined by a single rib. The umbone of the posterior valve is more posterior than in the drawing, and the valves are of a uniform brown color. The mantle is of the same color as the valves." These characters seem to me to indicate a distinct species, which may be called *Tonicia subatrata.*

T. SWAINSONI Sowerby. Pl. 43, figs. 41, 42. 43,

Shell oval, moderately or decidedly elevated, somewhat carinated, the side-slopes nearly straight. Ground-color light pinkish-buff, *painted all over with a multitude of red or red-brown lines, concentric to the beaks;* often having some valves striped at or on each side of the ridge, or more or less completely covered with dark red-brown.

Lateral areas little raised, *sculptured with about* 8 *radiating*

riblets, the riblets sometimes broken into rows of distinct granules. *Central areas longitudinally costulate* except for a narrow, smooth dorsal band on the latter 6 valves. End valves radially ribbed, with rows of eyes in the intervals. Umbo of tail valve anterior, elevated.

Interior white, some or all of the valves having a small reddish spot under the apices. Sinus narrow, denticulate. Anterior valve having 8, central 1, posterior valve 10–12 slits; teeth pectinated.

Girdle yellow or brown, leathery, thin.

Length 34, breadth 20 mill.; divergence 100°–110°.

Callao, Peru.

C. swainsonii SOWB., P. Z. S. 1832, p. 27; Conch. Illustr., f. 5.—REEVE, Conch. Icon., t. 7, f. 38.—*Lophyrus swainsonii* TAP.-CAN. Viag. Magenta, p. 75.

This species is well differentiated from forms of the *elegans* group, by the longitudinal ribbing of the entire central areas. The ribs vary much in prominence, however, and in many individuals the riblets of the lateral areas are broken into granules. The color-pattern is similar to that of *T. lineolata*, but finer.

T. RUBRIDENS Pilsbry, n. sp. Pl. 44, figs. 65, 66, 67.

Shell oblong, elevated, the dorsal ridge roundly angular, side-slopes straight. Surface smooth. Tawny-brown, sometimes unicolored, but generally having dotted light rays on lateral areas and end valves, and a dark dorsal band. A light fawn color sometimes predominates over the dark.

Valves rounded at the front corners, moderately beaked; sutures not crenulated.

Lateral areas not perceptibly raised (except on the second valve), *sculptured with minute granules sparsely and irregularly scattered*, varying much in number; and along the forward part there is *one series of small black eye-dots*, becoming an irregularly double series on the lower half of the slope. End valves weakly granulose and having radiating rows of eyes. *Central areas entirely smooth except for growth-lines, having no grooves along the dorsal ridge.* Beak of tail-valve obtuse, *behind the middle.*

Interior of a peculiar red-brown color, the callus of each valve whitish. *Sutural-plates thin, red-brown.* Sinus delicately denticulate, the area behind it, extending to the beak, transversely wrinkled. Slits in anterior valve 8, central valves 1, posterior valve

9; teeth finely crenulated outside and at edge, rather thin, and colored red. As in other species having a posterior mucro, the tail-valve teeth are directed forward.

Girdle yellowish, leathery, nude and smooth.

Length 28, breadth 15 mill.; divergence 108°.

Callao; and Chili (U. S. E. E.)

This species differs from all of the *T. elegans* group in lacking sculpture upon the central areas and engraved grooves along the dorsal ridge; and from other species of *Tonicia* in the red sutural-plates, teeth, etc. The blunt mucro is posterior, and the teeth in the tail-valve are directed forward. The posterior margin of the tail valve is broadly waved upward in the middle, as in *Eudoxochiton*.

T. HORNIANA Rochebrune. Pl. 43, figs. 50, 51.

Shell ovate-elliptical, carinated, rufous, marbled with buff and roseate; anterior valve radially costate, posterior valve small; intermediate valves having the central areas minutely concentrically striated; lateral areas multi-sulcate and ornamented with two lines of dots. Marginal ligament dull roseate.

Length 19, breadth 14 mill. (*Rochebr.*)

Orange Bay, Patagonia.

T. horniana ROCHEBR., Polyplac. Cap Horn, p. 139, t. 9. f. 7.

T. MARTIELI Rochebrune. Pl. 43, figs. 48, 49.

Shell ovate-elongate, strongly carinated, the ends of the valves curved backward, brown-rose, anterior valve radially strongly costate; posterior valve small; intermediate valves having the central areas transversely lineated, lines denticulate; lateral areas granulated and margined by a squamate band. Marginal ligament violaceous-rufescent. Length 21, breadth 14 mill.

Straits of Magellan.

T. martieli ROCHEBR., Polyplac. Cap Horn, p. 139, t. 9, f. 8 (1889.)

T. LEBRUNI Rochebrune. Pl. 43, figs. 52, 53.

Shell ovate-elliptical, carinated, shining, violaceous or greenish-roseate. End valves radially most minutely striated; intermediate valves having the lateral areas covered with tubercles; the central areas concentrically sulcate, the sulci wavy; marginal ligament narrow, leathery, whitish-violaceous.

Length 29, breadth 12 mill. (*Rochebr.*)

Punta Arenas, Orange Bay, St. of Magellan.

Tonicia lebruni ROCH., Bull. Soc. Philomath. Paris, 1883–'84, p. 35; Polyplac. Cap Horn, p. 138, t. 9, f. 6.

T. FONTAINEI Rochebrune. *Unfigured.*

Shell ovate, broad, subcarinated, gray, with brown spots. Anterior valve, lateral areas of intermediate valves, and posterior part of posterior valve very delicately striatulate and sparsely covered with conic tubercles; central areas sculptured with beaded longitudinal waved lines. Marginal ligament rather wide, leathery, rufous.

Length 11, breadth 9 mill. (*Rochebr.*)

Chili (M. Fontaine); Paris Museum.

Tonicia fontainei ROCHEBR., Bull. Soc. Philom. de Paris, 1881–1882, p. 193.

The foregoing species are not defined with sufficient exactness to insure their indentification, Rochebrune being a century behind the times in descriptive zoölogy.

T. ARGYROSTICTA Philippi. *Unfigured.*

Girdle smooth. Valves smooth, subcarinated; lateral areas having a single series of distinct silvery impressed dots.

Length 4½, breadth 3 lines.

This small species is sufficiently distinguished by the peculiar impressed silvery-shining points, which remind one of the similar marking on some Carabidæ. On both end valves they stand in several concentric rows. The coloring varies; the brown-red color predominating; in one example there are whitish flecks and transverse stripes, in another longitudinal stripes. (*Phil.*)

Straits of Magellan.

Chiton argyrostictus PHIL., Archiv für Naturg. 1845, p. 59.

T. ZSCHAUI Pfeffer. Pl. 40, fig. 12.

The animal is much elongated, the breadth hardly one-half the length. The inner region of the girdle is covered with very minute granules, hardly visible under a strong lens, arranged in not entirely regular oblique series, and separated by about their own dimensions. Under a low-power lens the girdle appears quite naked. Toward the margin these granules grow into transparent, short spines. The 28 branchiæ reach the entire length of the foot.

The valves are quite shining, and sculptured with close growth-striæ; otherwise they appear smooth under a weak power of the lens; under strong magnification a fine granulation is visible. The median valves have only a low angle separating central and lateral

areas; the growth wrinkles, which on the lateral areas are close and prominent, are weaker on the central areas, the posterior part of which appear sculptureless. The umbo seems to be produced backward [beaked] in young shells, but in this specimen it is so upon the 2d valve only. The dorsal ridge is bluntly angular. The head valve is long compared with its breadth, the length of the front slope equalling that of each of the posterior margins; it shows weak concentric sculpturing of striæ. The tail-valve is small and narrow, not much more than two-thirds as broad as the head valve, and also notably shorter; its forward area is not shining; the posterior segment is shining and sculptured like the head valve.

The lateral areas and the outer anterior parts of the central areas are yellowish-red with red marbling. The central area shows on its middle part, a group of beautiful chocolate-brown and violet-white striæ, radially diverging from the umbo. On the anterior median valves are seen also a few clear brown streaks on the outer part of the central areas.

The single specimen before me is fastened on pasteboard, and measures 13·5 by 6 mill.; the broadest valve is 5 mill., so that the girdle is but ·5 mill., wide. The third median valve of this specimen is abnormal in being pure white.

South Georgia.

Chiton zschaui Pfr. in Moll. Süd-Georgien, Jahrb. Hamb. Wissensch. Anstalten iii, p. 105, t. 3, f. 2 (1886.)

This is placed in *Tonicia* with much doubt, for the presence of eyes is not noted in Pfeffer's description, above.

T. tehuelchus d'Orbigny. Pl. 40, figs. 13, 14, 15.

Shell oblong, elevated, strongly carinated; brown with two white longitudinal zones; head-valve and lateral areas radially sulcate-bifurcate; central areas longitudinally punctate-sulcate.

Length 27 mill. (*Orb.*)

Bay of San Blas, Patagonia.

Chiton tehuelchus Orb., Voy. dans l'Amér. Mérid., p. 488, t. 65, f. 7–13.

The sculpture reminds one of *Chætopleura fulva* Wood. The generic position is not certain.

2. *West Indian species.*

T. schrammi Shuttleworth. Pl. 43, figs. 54, 55, 56.

Shell oblong, moderately elevated, roundly angular. Surface polished. *Ground-color buff, mottled, speckled or sometimes suffused*

with bright reddish-brown. Valves strongly beaked, the umbo of the tail-valve far to the posterior (fig. 54). *Central areas smooth* throughout; *lateral areas* separated from the central by a prominent, rounded, curved diagonal rib, and *smooth* except for a broad band of black eye-dots, variously arranged, on the forward half; *sutures feebly or obsoletely crenulated.* Head-valve smooth except for 8–10 broad rays of eye-spots.

Interior white, stained with crimson along the jugal tract. Sinus obsoletely denticulate. Anterior valve having 9–10, central valves 1, posterior valve 14 slits; teeth deeply and regularly pectinated on outer face and edge. Posterior border of each valve inflexed and maculated with reddish.

Girdle leathery, tawny, flesh-colored.

Guadalupe; Florida Keys; Bermuda.

Chiton (*Tonicia*) *schrammi* SHUTTLW., Journ. de Conchyl. 1856, p. 171, t. 6, f. 9.—*T. schrammi* HEILPRIN, The Bermuda Is., p. 176. DALL, Catal. Moll. S. E. U. S., p. 174.

This form differs markedly from those of Western South America in the non-sculptured central areas, prominent diagonal rib (like that of *T. crenulata*), and broad bands of eye-spots. The umbo of the tail-valve is far backward, and in most specimens the posterior margin of the same valve is distinctly emarginate in the middle, the teeth being much shorter there and irregular. In this it resembles *Eudoxochiton.* The diagonal rib is more prominent, and the eyes far more numerous than in *T. rubridens.* The nearest ally of *schrammi* is the very differently sculptured *T. crenulatus.*

3. *Species of Australia, New Zealand, Philippines, etc., etc.*

T. SUEZENSIS Reeve. Pl. 40, figs. 16, 17.

Shell oblong ovate, valves very closely concentrically wrinkled at the sides, with oblique wrinkles toward the middle; yellowish, delicately stained with pale scarlet and green; ligament horny. (*Reeve.*)

Gulf of Suez.

C. suezensis REEVE, Conch. Icon., t. 20, f. 134 (May, 1847).—ISSEL, Moll. Mar Rosso, p. 235.—COOKE, Ann. Mag. N. H. 1885, p. 276.—? SAVIGNY, Descr. Aegypte, t. 3, f. 4.—*Tonicia ? suezensis* CPR., *MS.*

Carpenter writes: Mucro subposterior-median, rectangularly elevated. Interior: anterior valve having 8, central 1, posterior valve 13 slits; posterior teeth shorter, bending forward, anterior

teeth sharper, very deeply pectinated. Eaves wide; sinus minutely denticulated. This species and the following, with *truncata*, are intermediate between *Tonicia* and *Acanthopleura;* but they agree with this genus in the porcellanous texture, deep slits, angular denticulated sinus and pectinated teeth. The slight lanugation of the girdle appears to be a secondary character.

T. NIGROPUNCTATA Carpenter. *Unfigured.*

Shell small, rather elongated, elegantly clouded olivaceous and brown; moderately arched, the dorsal ridge obtuse. Lateral areas moderately defined, ornamented with radiating and longitudinal wrinkles irregularly decussating, with black dots scattered between them. Central areas having subparallel, subdecussating, scarcely regular ribs, obsolete at the jugum. Mucro posterior, elevated.

Interior having 8–10 slits in the anterior, 1 in the central, 12–14 in the posterior valve; teeth in the posterior valve solid, sloping, short; sinus broad, denticulate. Girdle copiously clothed with hair-like scales. Length 12, breadth 6·2, alt. 1·7 mill. (*Cpr.*)

Tahiti. (Pease.)

Acanthopleura nigropunctata CPR., P. Z. S. 1865, p. 511.—PEASE, Amer. Journ. Conch. vii, p. 194.—*Tonicia nigropunctata* CPR., *MS.*

This species is most closely allied to *T. suezensis*, but the latter has the valves more beaked and curved, and the central rugæ perpendicular to the diagonal lines, while in this they are nearly parallel to the dorsal ridge. (*Cpr.*)

T. FORTILIRATA Reeve. Pl. 40, figs. 3, 4 (enlarged.)

Shell ovate; valves somewhat beaked in the middle; posterior valve umbonated, blunt; lateral areas rather concave, granulated anteriorly; central areas strongly arcuately ridged. Yellowish variegated with green, stained with red in the middle. Ligament horny. (*Reeve.*)

Raines Island, Torres Sts. (Ince); *Port Darwin*, 8–10 fms. sand and mud (Coppinger.)

Chiton fortiliratus RVE., Conch. Icon., t. 18, f. 112.—*C.* (*Tonicia*) *fortiliratus* SMITH, Zool, 'Alert' p. 84.

Carpenter writes of the type: Anterior valve having 6, central valves 1, posterior valve 13 slits; teeth short, numerous, very sharply pectinate; short at the hinder end but gradually becoming a little longer. Eaves short, slightly rugose, not spongy; sinus with about 20 teeth, rather broad, flat. Interior whitish. Outside ashy

variously pencilled and marked with olivaceous; beaks small, conspicuous. Jugal area very small, smooth in front. Central areas with about 20 smooth riblets, curving toward the middle on the median part of the areas, and toward the outside of the areas radiating outward. Lateral areas scarcely raised, having faint rows of granules; at diagonal rib and at sutures having slight elongated granules toward the sutural ribs and rows of metallic dots next the diagonal ribs. Anterior valves with granules and irregular rows of metallic dots alternating; crenate at suture. Posterior valve with median, raised, swollen mucro; posterior slope straight. Length 28, breadth 18 mill.

The single specimen collected by Coppinger is thus described by Smith: It is of a greyish-pink color, copiously blotched with black along the sides of some of the valves. The headplate * * * insertion edge is much thickened, coarsely striated externally, and is divided by 8 short narrow slits. The exterior surface is coarsely subsquamately granulated throughout, and exhibits numerous black raised dots, disposed in rather irregular radiating series. The second valve is long in comparison with those which follow, feebly peaked behind; the fourth, fifth and sixth plates are about equal in size and a trifle broader than the third and seventh. All the intermediate valves are very coarsely ridged and sulcated on the central areas, and coarsely grained and minutely black-dotted on the sides (lateral areas). The ridges are flat-topped, clean-cut, nearly smooth, attenuated posteriorly, wavy, converge on each side toward the front, and the intervening grooves are feebly punctate. All have the hinder margin nearly straight and but feebly pointed at the posterior apex. * * * The posterior valve is strong and thick, obtusely mucronated in the center, very coarsely striated and serrated upon the thickened insertion-margin, which is subdivided by about 10 distinct notches. The interior of the valve is light livid bluish, with a reddish stain along the middle of all, with the exception of the last. The mantle, as described by Reeve, is simply "horny." Length, without girdle, 18, diam., of fifth valve 9 mill. Reeve's type is a larger specimen, being 24 mill. long, 13 wide, without girdle.

T. CARPENTERI Angas. Pl. 40, fig. 7.

Shell ovate, elevately convex, carinated, ashy white, ornamented at the hinder edges of the valves with pale spots, the spaces between which are very dark olive, melting into confused bands of a paler hue which extend nearly across the valves; valves rostrate, undul-

ately concentrically subimbricately sculptured throughout; the lateral areas not raised but separated from the dorsal areas by an elevated rib. Posterior valve strongly gibbous, the umbo almost terminal; mantle margin brown. Length 9 lines. (*Angas.*)

Port Jackson, Australia.

Tonicia carpenteri Ang., P. Z. S. 1867, p. 116, 223, t. 13, f. 30.

Carpenter gives the following descriptive notes:

One specimen without anterior valve. The specimen as it stands measures length 17, breadth 15 mill.; but measuring the valves only and allowing for the missing anterior valve it would be length 16, breadth 10 mill. Shell oval, moderately elevated, the dorsal ridge acute; olive clouded with dark, tessellated with light so as to appear toothed at the sutures. Mucro central, swelling, elevated, the posterior slope convex. Jugal area a rather narrow, nearly smooth dorsal line. Central areas with about 16 finely, rugosely sculptured, nearly concentric, but faint, grooves on the otherwise smooth surface. Lateral areas slightly raised by the curved diagonal; having lines of stumpy granules and concentrically rugosely grooved in continuation of the sculpture of the central areas, obsolete at sutures. Posterior valve concentrically grooved like the rest, all around. Girdle nearly smooth, very slightly lanugate. Posterior valve with 11 slits; teeth rather sharp, grooved outside; eaves very small. Sinus broad, flat, deep, having about 17 very slight teeth.

This species is a transition toward *Acanthopleura* in the thrown-forward teeth, but girdle and sinus are more Tonicioid. (*Cpr.*)

T. lamellosa Quoy & Gaimard. Pl. 40, figs. 8, 9, 10, 11.

Shell small, oval-elongate, subelevated, carinated; valves transversely scaly-striated, variegated with gray or ferruginous; girdle thick, smooth, reddish marked with radiating brown lines. Anterior valve having 10 crenulated teeth, posterior 9, and a much projecting tuberosity. Color of valves grayish-yellow, varied with brown, red or greenish. Girdle usually yellow. (*Q. & G.*)

Length 15, breadth about 8, alt. 5 lines.

Tonga Tabu.

Chiton lamellosus Q. & G., Zool. Astrol. iii, p. 386, t. 74, f. 29–32.

This species has the mucro more posterior than any of the preceding species.

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T. CONFOSSA Gould. Pl. 57, figs. 33–36.

Shell oblong, solid, elevated, the side-slopes straight, dorsal ridge carinated. Ashy white, delicately maculated with various shades of reddish and purple-brown, the darker color irregularly tessellating the posterior margin of each valve.

The median valves are moderately beaked ; the lateral areas a little raised, and posteriorly and on the diagonal are very peculiarly sculptured with *transverse narrow ledges, like the edges of shingles imbricating from the outer margin of the valve upward ;* median portion of the lateral areas smooth, *dotted in a widening band with eyes.* Central areas peculiarly marked with *sparsely scattered subtriangular pits,* in some places arranged in irregular transverse rows. Anterior valve having radiating series of Λ-shaped imbricating large scales, alternating with narrow bands sparsely dotted with eyes. *Posterior valve having the prominent mucro near the posterior end, the slope behind it vertical,* in front of it horizontal ; a narrow band of eye dots is behind each diagonal, and they are very sparsely scattered over the rest of the posterior area.

Interior white. Sutural plates separated by a moderate sinus, which is delicately denticulate except in the second valve. Anterior valve having 8, median 1, posterior 15 slits ; the teeth sharply and deeply pectinated outside ; posterior teeth somewhat directed forward, deeply pectinated, the slits rather shallow. Eaves narrow, slightly projecting downward near the teeth, and very narrowly grooved just outside of them.

Girdle blackish-brown, rather fleshy, nude.

Length about 18, breadth 11 mill. ; divergence 120°.

Fiji Is.

Chiton confossus GOULD, Proc. Bost. Soc. Nat. Hist. ii, p. 143 (July, 1846) ; Expedition Shells, p. 5 ; Wilkes' Expl. Exped. Moll., p. 327, atlas f. 434, *a*, *b*, Otia Conchologica, p. 5.—*Chiton* (*Lucia*) *confossus* GOULD, Otia, p. 242.—*Lucia confossa* GOULD, Proc. Bost. Soc. viii, p. 283.—*Lucilina confossa* DALL.

The prominent, posterior mucro, and the peculiar sculpture render this species easily identified. It belongs to that numerous East Indian group (see p. 206) characterized by a rather swollen posterior or post-median mucro, forward-tending posterior teeth, and by the generally punctured grooves of the surface-sculpture ; but in this species the character of the sculpture is unique in the total obsolescence of concentric or forwardly converging riblets on the

central areas, and the development of angular scattered pits there. The tail-valve is emarginate behind as in *Eudoxochiton* and many Tonicias. Fig. 33 represents the interior of the second valve, which is longer than the following valves, as usual in *Tonicia*.

It is not easy to see how Gould could write so confidently of the plurality of side slits, unless he examined the figures in the Exploring Expedition Atlas instead of the specimen itself; but this is no doubt the case. The artist of the expedition in drawing these figures, mistook the deep pectination for veritable slits, and represented them as such. In the figured specimen, now before me, the girdle in drying has parted from the eaves, partially exposing the deeply pectinated insertion-plates, as represented in figures 434 *b* of the Atlas; but as I have above explained, the deeper grooves of the pectination have been very erroneously drawn in those figures as slits. The fact is that although the grooves are strong and deep on the outside of the plates, they scarcely crenulate the summits of the teeth, and are as different as possible from true slits.

The genus or subgenus *Lucia* (*Lucilina*) has therefore no standing whatever, but becomes a synonym of *Tonicia*. This species cannot be included in *Acanthopleura* on account of the different arrangement of the eyes, the smooth girdle (which in this species seems to be more fleshy than leathery), and the denticulate sinus.

T. PICTA Reeve. Pl. 40, figs. 5, 6.

Shell ovate; valves, the posterior terminal truncated, ornamented with short, sharply undulated wrinkles, the interstices between which are punctured; anterior edge of the lateral areas keeled; pinkish-white, showily painted with green and scarlet spots. Ligament horny, transparent. (*Rve.*)

Raine's Island, Torres Sts. (Capt. Ince.)

C. pictus REEVE, Conch. Icon., t. 15, f. 79 (March, 1847.)

Allied to *C. truncatus*, distinguished by its sculpture and flattened growth. (*Rve.*)

T. TRUNCATA Sowerby. Pl. 40, figs. 1, 2.

Shell oblong, rather elevated, the dorsal ridge rounded; ashy-flesh colored, variegated with darker or olivaceous, dotted with black, and sometimes rose-tinted along the dorsal ridge.

Valves much rounded and separated at the ends; entire surface granulose; central areas engraved with superficial waved grooves;

lateral areas hardly elevated, irregularly rugulose. Mucro behind the middle, much elevated.

Inside having 10 slits in the anterior, 1 in the median, 14 in the posterior valve; teeth of the tail valve directed forward; those of the central and front valves sharper, deeply serrated outside and at the edge. Sinus moderate, deep, flat, with about 20 delicate denticles. Length 38, breadth 20 mill.

Siquijor, Philippines.

Chiton truncatus Sowb., P. Z. S. 1841, p. 61.—Reeve, Conch. Icon., t. 16, f. 93.—*Acanthopleura ? truncata* Gray, P. Z. S. 1847, p. 68.—*Tonicia truncata* Ads., Genera i, p. 474, and of Shuttlw. and Cpr.

Resembles *Tonicia* (*Fannettia*) *disjuncta* in the partial separation of the valves at the sutures. The tail-valve is formed much like that of *Acanthopleura*.

A variety with nearly smooth valves has been noted from Samar. Carpenter described in MS. a Cumingian specimen as *T. jugosulcata*, said to be from Tasmania, but he later regarded it as a form of *truncata*. The locality Tasmania is very doubtful.

Section *Fannettia* Dall, 1878.

Tonicia § * * , Gray, P. Z. S. 1847, p. 67.—*Fannyia* Gray Guide Moll. B. M., p. 185 (1856).—*Fannia* Cpr., not *Fannia* Robineau Desvoidy, 1830.—*Fannettia* Dall, Proc. U. S. Nat. Mus. 1882, p. 284, 287, 289.

This section is like *Tonicia* in all respects except that the mucro is flattened, the teeth of insertion are somewhat longer, and the broad girdle encroaches upon the valves at the sutures, nearly separating them.

T. disjuncta Frembly. Pl. 39, figs. 35–41.

Shell oblong-ovate, reddish-brown, with green and straw-colored markings; valves smooth, glossy, the anterior margins of the dorsal valves are arcuate, the beak only of the next forward valve covering them, giving the valves a disjointed appearance. Lateral areas low; mucro of tail valve median, subplanate.

Inside white; anterior valve having 9, central 1, posterior valve 9 short slits; teeth elongated and strongly grooved outside; delicately serrated at the acute margins; teeth of tail valve short and solid behind, elongated in front. Eaves narrow; sinus denticulate.

Girdle smooth, broad, extending between the valves, and when living marbled with vivid red, green and blue.

Length 62, breadth 37 mill.

Valparaiso, Chili.

Chiton disjunctus FREMBLY, Zool. Journ. iii, p. 203, suppl. pl. 17, f. 5 (between Oct., 1826 and May, 1827).—REEVE, Conch. Icon. t. 4, f. 21.—GOULD, U. S. Expl. Exped., Moll. and Sh., p. 329.—*Fannyia "dispuncta"* [err. typog.] GRAY, Guide, p. 185.—*Fannia disjuncta* CPR., *MS.*

"The transitions between this species and the normal *Toniciæ* are so gradual, that it scarcely seems entitled to generic rank. The valves are not much more covered than in *T. truncata;* but instead of the lateral sinuses being angular, they are gradually rounded, and extended to the apices of the valves. The principal peculiarity is in the flattening of the mucro; the creature, having devoted itself to lateral expansion, had no need to push its tail up into a hump. The slits are as short as if the valves were fully exposed, only extending up one-third of the teeth in the anterior valve and one-half in the others. Inside, however, the gums rise to the level of the slits, so that, when seen from within, the shell appears perfectly normal. According to Gould, E. E. Moll., p. 329, the girdle is "distinctly cleft" behind. This is duly represented in the Atlas, f. 417. I have not, however, been able to trace it in either of the specimens examined. That in Dr. Gould's own cabinet, although in good condition, shows no trace of it. Neither Frembly nor Gray allude to it. (*Cpr.*)

Genus XV. ACANTHOPLEURA Guilding.

Acanthopleura GUILD., Zool. Journ. v, p. 28 (in part), + *Corephium* GRAY, *Maugeria* GRAY, *Francisia* CPR.

Valves exposed, beaked, generally lusterless or eroded; provided with eyes on the forward part of the lateral areas and the end valves; mucro posterior; interior colored, the tegmentum broadly inflexed at the posterior margin of each valve. Insertion-plates all conspicuously pectinated outside, and directed forward. Girdle thick, covered with small or large calcareous spines.

History of the name Acanthopleura.—Under Acanthopleura, Guilding defined seven sections, naming a representative of each. His scheme is here reproduced, the modern equivalents of the species named being added in brackets:

* Zona spinosa. *Chiton spinosus* Sow., Gen. f. 1. [=*Acanthopleura spinosa* Brug.]

** Zona spinulosa. *Ch. carmichaelis* Gray, Spicil. [=*Plaxiphora.*]

*** Zona granulosa. *Ch. asellus* Lowe, Zool. Journ. [=*Lepidopleurus*, p. 13.]

**** Zona rugoso-granulosa. *Ch. asselloides* Lowe. [=*Trachydermon albus* L., p. 70.]

***** Zona crinita. *Ch. crinitus* Wood, Index. [=*Acanthochites.*]

****** Zona villosa. *Ch. peruvianus* Frembly. [=*Chætopleura*, p. 28.]

******* Zona farinosa. *Ch. cinereus* Lowe. [=*Trachydermon*, p. 68.]

As neither of these sections were selected by Guilding as the typical group, we are obliged to select a type for ourselves; and of course *the choice must be limited to the species actually enumerated by name in Guilding's scheme of sections.* We must first exclude such species as are already provided with generic names; and glancing down the list we therefore, eliminate section ***, which falls into Risso's earlier genus *Lepidopleurus*, and section *****, which belongs to *Acanthochites* Risso. Of the five sections remaining, ** was separated by Gray in 1847 under the name *Plaxiphora.* Section ****** was denominated *Chætopleura* by Shuttleworth in 1853; and for the species included in sections **** and *******, Carpenter established the genus *Trachydermon*, in 1863. These successive dismemberments have left only the *first section* of Guilding's arrangement, to represent the original genus; and *Chiton spinosus*, therefore, becomes the type of *Acanthopleura* Guilding.

Unfortunately for science, few authors have arrived at this result; but the fact that it rests upon principles of nomenclature from which there is no appeal, will, it is believed, be evident to all.

Since Guilding's publication of the name, it has been considered by the following systematists:

1840. Swainson defines the genus (which he calls "*Canthapleura* Guild."), and names "*C. spinosus*, Sow. Gen., f. 1" as the representative or type. No other species is mentioned.

1847. Gray defines the genus, including in it sections as follows:

* *A. peruviana* Lm., *bicolor* Ad., *hennahi* Gray, *watsonii* Sowb. [=*Chætopleura* + *Ceratozona.*]

* * This divides into three subsections:

† *A. nobilis* Gray. [=*Eudoxochiton.*]

† † *A. picea* Sow., *spinigera* Sow., *owenii* Gray, *spinosa* Brug., *brevispinosa* Sow., *magnifica* Gray. [=*Maugeria.*]

† † † *A. ? gigas* Gmel. [=*Dinoplax*]; *A. ? truncata.* [=*Tonicia.*]

Neither of these sections is selected by Gray as typical; but in his "List of the Genera of Recent Mollusca, their synonyma and types" P. Z. S. 1847, he gives on p. 168, no. 413, "*Acanthopleura* Guild. 1835; Gray, 1847. *Canthapleura* Swains., 1840. *Ch. spinosa.*" It appears then that not only Swainson, but Gray himself selects *C. spinosus* as the type species.

1853. SHUTTLEWORTH, in a most scholarly essay, divided Gray's *Acanthopleura* of 1847 into three sections: *Chætopleura* [equivalent to Gray's sect. * and part of † † †, and including *C. rugosus* (Gray) Sowb., *peruvianus* Lm., *gigas* Chem.]; *Eudoxochiton* [for *C. nobilis* Gray]; and *Acanthopleura*, restricted, [equal to Gray's *Acanthopleura* sect. † † plus *Corephium*, with some other miscellaneous species].

In 1856, GRAY again made a cruel onslaught upon the genus; and here he restricts *Acanthopleura* to the sect. * of his 1847 arrangement, ignoring the fact that Shuttleworth had meantime given a new name, *Chætopleura*, to that section, and apparently forgetting that he had himself said in a former paper that *C. spinosus* was the type of *Acanthopleura!* In the same paper, he proposes a new genus, *Maugeria*, for the following species, which he arranges in two sections: †, *M. nobilis* [=*Eudoxochiton* Shuttl. 1853]. † †, *M. picea* Sow., *spinigera* Sow., *owenii*, *spinosa* Sow., *brevispinosa* Sow., *magnifica* Sow., C. Ill., f. 52. He also retains his genus *Corephium* for *C. echinatum* Sow., Ill., f. 47.

1858. Messrs Adams, in their Genera, reunite *Acanthopleura* and *Corephium*, with a choice assortment of other forms, under the genus "*Chiton Linnæus.*" As the status of this generic name has been fully discussed by me on p. 150, comment here would be superfluous.

1873–1882. Carpenter, in his MS. arrangement of *Chitons* (an abstract of which was published by Dall, Proc. U. S. Nat. Mus. 1881, p. 284, 287), proposes to retain the name *Acanthopleura* for the group of *Ch. piceus; Corephium* for *C. echinatus;* and *Francisia* Cpr., *nov.*, for *Ch. spinosus.* This arrangement is not acceptable

because (1) *Ch. piceus* is not mentioned in Guilding's essay, and therefore cannot be the type of his genus. We are not concerned with the shadows of species dimly visible upon Guilding's pages, but with the species actually enumerated by him, with name and reference. (2). *Francisia* being founded upon the type of Guilding's *Acanthopleura*, falls as a synonym.

The eyes, in this genus, are generally obliterated by erosion except at the edges of the valves, but they are present in young individuals, as in *Tonicia*. They are smaller than in *Tonicia*, and more numerous. In *Mesotomura* they are excessively numerous, minute and oval. In *Acanthopleura spiniger* they are larger, circular, and scattered around the bases of the tubercles on the lateral areas. In *Maugeria granulata* they are more numerous and more scattered.

The interior layer of the valves is very solid and dense, as in *Eudoxochiton* and *Tonicia*, even the jugal tract inside and the slit-rays lacking punctures. The tegmentum is deeply grooved over the teeth and sutural-plates.

Although but few well-differentiated species of *Acanthopleura* are known, the range of individual and local variation is great, and consequently an extensive literature has arisen, and the synonymy of the species is exceptionally involved. It is not improbable that some other valid species exist, but if so, they have not yet been recognizably defined.

The group *Lucia* Gld. (*Lucilina* Dall) has been considered a subgenus of *Acanthopleura*, but it proves to be a synonym of *Tonicia*.

The genus *Acanthopleura* differs from *Tonicia* mainly in the duller and sculptured valves, having the tegmentum more broadly inflexed over the posterior margins; in the more numerous, smaller eyes, the fleshy girdle clothed with large or small calcareous spines, etc. It is not especially allied to any other genus, but some species of *Liolophura*, a genus near *Onithochiton*, are externally very similar to species of the subgenus *Maugeria*. They may be distinguished at once by the smooth toothless ridge in place of the insertion-plate in the tail valve.

All of the species can be readily identified by the following key, whether the girdle-covering be preserved or not. It is necessary to remove the posterior valve of a specimen, which may be done by soaking it for some hours in warm water. The arrangement here given is believed to be perfectly natural.

Key to subgenera and species of Acanthopleura.

A. Insertion-plate of tail-valve long, crenulated outside, and with a median slit behind, other slits subobsolete or wanting; girdle beset with spike-like spines; sinus denticulate; interior purple-brown in the cavity and transversely engraved; the sutural-plates white, (*Mesotomura*), *A. echinatum.*

AA. Insertion-plate of tail-valve long, crenulated outside, and cut by numerous slits; median valves much wider across the sutural-plates than across the tegmentum or outer coat of the valve; interior not engraved (*Acanthopleura s. s.*)

a. Interior purple in the cavity, sutural-plates white; median valves occasionally Radsioid; sinus of second valve feebly denticulate; girdle broad, with long black spines; exterior black, *A. spinosa.*

aa. Interior livid-flesh or livid purple-colored; median valves 1-slit; sinus smooth; girdle wide, with numerous spinules; exterior dull, generally eroded, *A. spinigera.*

AAA. Insertion-plate of tail-valve short, blunt; median valves as wide or wider measured across the tegmentum than across the sutural-plates; sinus smooth.

a. Insertion-plate of tail-valve cut into teeth by 7–11 well-developed, subequal slits (*Maugeria.*)

b. Interior sea-green (intense or faded), with a black tract behind the sinus; spines of girdle very small, valves generally eroded, *A. granulata.*

aa. Insertion-plate of tail valve crenulated, having an oblique slit on each side, the ridge between them either continuous or unevenly serrated (*Amphitomura.*)

b. Median portion of tail insertion-plate irregularly serrated, but without true slits like the lateral tail slits; cavity of valves purple-black, sutural-plates white; valves usually not eroded outside, uniform black, granulated at the sides; girdle-spines rigid, black, tipped with buff, *A. brevispinosa.*

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bb. Interior of valves blue-white, with a black tract behind the white-edged sinus; exterior black with a light stripe on each side of the dorsum, sides granulated; girdle black, *A. borbonica.*

Subgenus MESOTOMURA Pilsbry, 1893.

Mesotomura PILS., in the Nautilus vi, p. 105 (Jan., 1893).—*Corephium* GRAY, P. Z. S. 1847, p. 65, 68.—Not *Corephium* BROWN, Ill. Conch. G. B. edit. I, 1827.

Acanthopleura: Valves transversely engraved inside, and having the sinus denticulate; tail valve having a long, continuous insertion-plate, slit only in the middle. Girdle beset with spike-like spines.

A monotypic subgenus related to typical *Acanthopleura.* It is remarkable for the stout spines of the girdle, the long, continuous insertion-plate of the tail valve, and the finely engraved interior. In the last character it can only be compared with *Enoplochiton niger,* which also resembles the present form in having oval eyes in the shell. In *Mesotomura* these eyes are excessively numerous, exceeding those of other *Acanthoids* in number.

A. ECHINATUM Barnes. Pl. 47, figs. 6–17.

Shell oval or oblong, solid, rather depressed but carinated on the dorsal ridge, the lateral slopes slightly convex. Dark brown; where eroded soiled white.

Valves strongly beaked, *having a narrow, smooth and elevated dorsal band,* with a shallow groove on each side of it, the sides of the *central areas closely and deeply engraved with fine flexuous grooves.* Lateral areas but little raised, shining, having *several radial rows of pustules standing upon a smooth ground,* which is *closely studded with minute eyes,* or the pits left by their destruction. Anterior valve having radiating, spaced rows of pustules; posterior valve having the mucro elevated and near the posterior margin.

Interior white, unicolored or stained with reddish in the depth of each valve; under a lens it is seen to be finely, closely engraved with transverse lines and elongated punctures on the forward slope of the central callus, and on the jugular area (fig. 12). Slits in anterior valve 8, central valves 1, posterior valve 1; teeth long, strongly pectinated. Sinus finely denticulate in all valves.

Girdle broad, fleshy, beset with strong spike-like spines. The gills extend the whole length of the foot.

Length 100, breadth 55 mill.; divergence 115°–120°.

Length 63, breadth 40 mill.

Payta, Peru (Dr. W. H. Jones); *Galapagos* (P. Ac. Coll.); *Valparaiso, Chili* (Frembly.)

Chiton echinatus BARNES, Amer. Journ. Science and Arts, (Silliman's) vii, p. 71, t. 3, f. 4*a*, 4*b*. (1823).—SOWERBY, Conch. Illustr., f. 47 (young).—*Chiton tuberculiferus* SOWERBY, Cat. Tankerv., p. 29, no. 688 (1825).—*Chiton spiniferus* FREMBLY, Zool. Journ. iii, p. 196, Suppl., pl. 16, f. 1 (1827).—*Chiton aculeatus* REEVE, Conch. Icon., t. 9, f. 49. Not *C. aculeatus* of DESH. *et al.*, nor of Linn.—*Chiton* (*Corephium*) *spiniferus* Frembl., STEARNS, Proc. U. S. Nat. Mus. xiv, 1891, p. 334.

This large, spiney species is not likely to be confused with any other, being very distinct in external features as well as in the peculiar insertion-plate of the tail-valve, the engraving of the interior (reminding one of *Enoplochiton niger* and *Chiton granosus*), and the denticulate sinus. The girdle spines are frequently encrusted with a white calcareous deposit, converting them into globular pellets. The young shell also lacks slits in the posterior insertion-plate (figs. 15–17, x 2); and the adults sometimes show an additional shallow notch or two near the median caudal slit.

Subgenus ACANTHOPLEURA, *s. str.*

Acanthopleura GUILDING, *l. c.* (part), and PILSBRY, The Nautilus vi, p. 105, Jan. 2, 1893.—*Francisia* CARPENTER in DALL, Proc. U. S. Nat. Mus. 1881, p. 284, 289, 290 (1882.)

Acanthopleura: Tail valve having a long, many-slit insertion-plate, crenulated outside; median valves much wider across the sutural-plates (or articulamentum) than across the exposed portion (tegmentum.)

The facts which cause me to consider this the typical group of *Acanthopleura* have been discussed above. The affinities of the subgenus are with *Maugeria* and with *Mesotomura*. With the latter it agrees in the coarsely spiney girdle, interior coloring, denticulate sinus and long insertion-plates; but it differs from that group in having a many-slit tail-plate, in the frequent (or usual) plurality of side-slits, the nearly smooth exterior, etc. In the form and dentic-

ulation of the valves, and in interior coloring, *A. spinosa* is very closely allied to *A. spiniger* Sowb., from which the occasional radsioid slitting, and the feeble denticulation of the sinus in the second valve, separate it specifically. Dr. Carpenter's subgenus *Francisia* included *A. spinosa* only.

A. SPINOSA Bruguiere. Pl. 45, figs. 80–87.

Shell oblong, depressed, smoothish and black; girdle wide, covered with long, brittle black spines.

The valves are smooth except for growth-lines on central areas and some inconspicuous radial wrinkling or obscure granulation on the *very feebly defined*, small, lateral areas. End valves somewhat rugose-granose radially, the mucro posterior.

Inside *purple-red in the middle*, white on the sutural-plates and the region of the lateral slit-rays. Sinus of second valve cut into delicate square denticles by short linear slits, but in the other valves the denticulation is obsolete. Slits in anterior valve 15, central valves 1 or 2, posterior valve 10; teeth of end-valves long, grooved outside and crenulated at the edges, the posterior teeth vertical; teeth of intermediate valves triangular, the posterior tooth, when present, very small. Sutural plates long, separated by a deep sinus broader than the plates.

Girdle wide, rusty, beset with long brittle black spines (fig. 86.)

Length 50, breadth 28 mill.

Albany Island, Cape York, North Australia (Challenger.)

Chiton spinosus BRUGUIERE, Journal d'Histoire Naturelle, i, p. 25, t. 2, f. 1, 2 (1792).—LAMARCK, An. s. Vert. vi, p. 321 (1819).—SOWERBY, Genera of Shells, Cephala, Chiton, f. 1; and Conch. Illustr. p. 1, f. 151.—REEVE, Conch. Syst. ii, p. 12, t. 134, f. 151; and Conch. Icon., t. 9, f. 51.—*Francisia spinosa* CARPENTER *MS.*—*Maugeria spinosus* GRAY, Guide Moll, B. M., p. 184.—*Francisia spinosa* HADDON, Challenger Rep., p. 30.

The radsioid slitting of some of the valves and the lack of distinct areas and valve sculpture, well distinguish this species. The slits are really very short, but are continued on the outside as grooves, up to the eaves. The eyes appear as minute amber colored beads, sparsely scattered down the forward half of the lateral areas, but scarcely arranged in rows. Poorly preserved or very old specimens show their pits only.

Nuttallina scabra Rve. bears a slight resemblance to this species, but it is differently sculptured, has smooth teeth and less spiny girdle. The tail-plate of *A. spinosa* is like that of *Katharina tunicata*, on account of the long, vertical teeth.

A. SPINIGER Sowerby. Pl. 48.

Shell oblong-oval, moderately elevated or depressed, lusterless, microscopically granulated and having a more or less developed sculpture of granules which either stand distinct or coalesce to form concentric wrinkles. Color dead-leaf brown or soiled whitish where eroded; generally black at dorsal ridge and sides of each valve or some of the valves; on each side of the black dorsal stripe there is generally a streak of green. Girdle broad, black or alternated with whitish. The valves are rounded at the ends, somewhat beaked; lateral areas but little raised, granulated or wrinkled, the forward part crowded with microscopic bead-like amber eyes. Central areas having wrinkles of growth and sometimes low, scattered granules, more numerous and stronger at the sides. Posterior valve having the mucro somewhat behind the center.

Interior of a purple-brown color, darker in front of the callus of the valve and on the sutural plates, lighter behind the callus of the valve. Sutural-plates broad, extending laterally much beyond the rounded ends of the tegmentum. Sinus rounded, sometimes black-edged. Anterior valve having 9–11, central valves 1, posterior valve about 7 (6–10) slits; teeth pectinated, those of the tail-valve much longer than the eaves.

Girdle *broad*, closely covered with calcareous black or buff spines

Length 70, breadth 43 mill.

Fiji Is.; Viti Is.; New Caledonia (A. Garrett in Phil. Acad. Coll.); *Cagayan, Isl. of Mindanao, and Siquijor, Philippine Is.* (Cuming); *New Guinea, New Ireland, and Tonga-Tabu*, (Quoy and Gaimard); *Port Essington* (Jukes); *Port Molle and Clairmont and Bird Island* (Coppinger); *Lat.* 10° 36′ *S.*, Long. 141°, 55′ *E.*, *Albany Island, Cape York, North Australia*, in 6 fms. (Challenger.)

? *Chiton aculeatus* LINNE, Syst. Nat. x, p. 667 (founded upon Rumphius Amboinische Rariteitkamer, pl. 10, fig. 4.)

Chiton nicobaricus aculeatus, CHEMN. Conch. Cab. x, p. 375, f. 1692.—*Chiton aculeatus* SPENGLER, Naturhist. Selskabet, iv, p. 78. —*Chiton aculeatus* QUOY & GAIMARD, Voy. de l'Astrolabe, Zool. iii, p. 373; atlas, t. 74, f. 1–5 (1834).

C. spiniger Sowb., Mag. of Nat. Hist. 1840, p. 287, Suppl. pl. xvi, f. 2; P. Z. S. 1841, p. 61; Conch. Illustr., f. 68.—Reeve, Conch. Icon., t. 14, f. 75.—*Maugeria spinigera* Gray, Guide Moll. B. M., p. 184 (1857).—*Acanthopleura spinigera* Cpr., *MS.* and Dall, Proc. U. S. Nat. Mus. 1882, p. 80.—*Chiton* (*Acanthopleura*) *spiniger* Smith, Zool. Coll. H. M. S. 'Alert,' p. 81 (1884); P. Z. S. 1891, p. 420.—*Acanthopleura spiniger* Haddon, Challenger Polyplac., p. 23.—*Acanthopleura balansæ* Rochebr. Bull. Soc. Philomath. Paris, 1881–2, p. 197.

?? *Maugeria owenii* Gray, Guide Moll. B. M., p. 184 (no description or figure).—?? *Chiton gemmatus* Blainv., Dict. Sc. Nat. xxxvi, p. 544.

It is now impossible to prove that this is, or is not, the *Chiton aculeatus* of Linné; but any one who will consult the original description, "*C. testa octovalvi striata, corpore subaculeato*," then turn to Rumphius' figure cited as an illustration, will be prepared to acquiesce in Hanley's suggestion (*Ipsa Linn. Conch.*) that the species be dropped as unidentifiable. Gmelin had no better information upon this species than we; and therefore his additional citations of figures are valueless. The mere fact that the figure cited by Linné represents an oriental species is offset by the absolute impossibility of knowing that it was an *Acanthopleura*.

Besides the localities given above, this species has been reported from Suez by Issel (Mal. Mar Rosso p. 235, and see also Cooke, Ann. Mag. N. H. 1885, p. 276), from Aden by Haddon (Challenger Polyplac., p. 24). It has been figured from the Red Sea by Savigny (see pl. 3, figs. 4, 1–2 of his folio). Probably Savigny's figs. 7, 1–3 of the same plate represent a young shell of the same, although I have seen none closely corresponding in sculpture. The eyes are distinctly drawn by the artist, a rather remarkable circumstance when we remember that no subsequent illustrations of Chitons show them! Additional localities are *New Zealand* reported by Q. & G. and *Hakodadi, Japan* by Schrenck (Amurl. Moll. p. 275); but these two localities must be regarded as doubtful until confirmed by either fresh specimens or a critical re-examination of the specimens and data in each case.

The study of the Indo-Pacific Acanthopleuras may be somewhat simplified by the elimination of (1) *A. borbonica*, characterized by a bifissate tail-valve (pl. 45, fig. 77) and (2) the "*Acanthopleura*"

incana of Australia and the so-called Acanthopleuras of Japan, which are characterized by a flat crescentic callus in place of the teeth in the tail-valve (pl. 53, fig. 35).

The variation of this species is great, and a number of subspecific or varietal forms will probably be distinguished eventually. My material is not extensive enough to permit me to diagnose these, or to indicate their areas of distribution; and I therefore offer below the original descriptions of the several described forms.

Typical SPINIGER is characterized by the possession of longer spines than any of the other forms. It is thus described by Sowerby:

C. spiniger Sowb. (pl. 48, fig. 22). Shell depressed, ovate-elongated, all over granulated; valves reclining, ends rounded; girdle wide, furnished with numerous subarcuate spines. Length 2·1, width 1·5 inch. Habitat——? Mus. Stainforth. Another spiniferous species, rather narrow in proportion to its length; depressed and finely granulated; the valves are rounded at the lateral extremities, with their apices leaning backward, and their lateral areas scarcely distinguished; numerous slightly curved spines, nearly one-half an inch long, cover the margin; general color like a faded leaf, with dark patches of reddish-brown covering the lateral and part of the central areas of some of the valves, and a dark dorsal band bordered by bright green and white (*Sowb.* in Mag. Nat. Hist.)

The fig. 22 is a copy of the original one published in Mag. Nat. Hist., and fig. 23 of that in the Conchological Illustrations, which probably represents the same specimen. Note the length of the girdle-spines.

Reeve's figure (pl. 48, fig. 27) represents a larger specimen, collected by Cuming in the Philippines. In this the spines are much shorter. Figs. 24–26, pl. 48, represent valves from a specimen very similar in all respects to Reeve's figure (see pl. 48, fig. 27). The granulation is rather obscure, or transformed into low wrinkles. The spines on the very wide girdle are both long and short (1–1½ mill.)

Figs. 31, 32, pl. 48, are drawn from a specimen from the Viti Is. collected by Andrew Garrett. In this specimen the dorsal ridge has a blackish-green band with a wider fleshy-white triangle on each side of it, and a streak of green, the rest of the surface of the valves being black except the large ashy-eroded patch on each side of the black (eroded) beaks. The central areas have some scattered gran-

ules on the light bands, and toward the diagonal lines; the lateral areas have rather coarse, irregular granules. The girdle is covered with alternate black and whitish patches of spines, these being all curved like a *Dentalium*, rather blunt, the longer of them measuring about 2½ mill. in length.

Another specimen, from New Caledonia, is similar, but has no white patches on the girdle, the spines being 3–3½ mill. long, and black, often tipped with light color.

The *C. macgillivrayi* Ad. (P. Z. S. 1855, p. 120) seems to be very similar, to this variety, if not identical; the original description follows:

C. macgillivrayi A. Ad. Shell oblong-oval, a little elevated; black, the central areas painted with two pale longitudinal stripes; valves obtuse, under a lens seen to be most minutely granulated, ornamented with concentric undulating rugose-grained liræ; terminal valve umbonated in front, umbo rather smooth, slightly produced; girdle set with black, curved, slightly obtuse calcareous spines. Feejee Islands, on the reefs (J. Macgillivray). This is a well-marked and handsome species, rather more than two inches in length; the surface of the valves is finely granulated and ornamented besides with subgranulated, wavy, concentric elevated lines; the central areas have a pale greenish band on each side of the umbo. (*Ad.*)

Carpenter gives the following notes upon the types: Four specimens, with A. Adams' autograph label. Bristles rather long for the group, crowded and curved, black, but often tipped with light as in *brevispinosa*. Sculpture with granules like *borbonica* in the young, but soon changing to concentric wrinkles. Mucro prominent, somewhat antemedian, the posterior slope convex. Jugal area granose; in one specimen only are there white streaks making V's on the valves. Sculpture of central areas gradually changing from grains into wrinkles toward the diagonals. Lateral areas scarcely distinguished; concentric wrinkles predominating. On the terminal valves the sculpture is much finer, the rugulæ breaking up into grains. Inside color dark. The divergence is very variable, one specimen being quite elevated, the others flatter; measuring 103°, 126°, 114°, 129°.

The *granatus* of Reeve seems to be an unusually granose example of *spiniger*, such as that figured on pl. 48, fig. 28. The description here follows:

C. granatus Reeve (pl. 48, figs. 29, 30). Shell oblong-ovate; valves strongly, roughly grained, especially at the sides; umbos smooth; dirty ash or stone color, grains blackish, umbonal eminence blotched with black; ligament horny, jet black. Habitat——? (*Reeve.*)

The figured type, according to Carpenter, has lost its anterior valve and girdle spines. The tail-valve should be examined in order to tell whether it is a specimen of *spiniger* or of *borbonica*, but I am disposed to believe it the former.

Fig. 28, of pl. 48 is drawn from a large specimen belonging probably to the *granatus* form. The dorsum has a green band flanked by creamy-flesh colored wider bands, more or less suffused with green. The surface is very strongly granulated.

Reeve's C. CUNNINGHAMI, to which *piceus* Rv. non Gmel. and *obesus* Shuttlw. may be added, probably represents a variety characterized by the large size, fine girdle-spines, etc.

C. cunninghami Reeve (pl. 49, figs. 33, 34). Shell oblong-ovate, valves rather thick, concentrically ridged throughout, radiated from the umbones with raised striæ; posterior terminal valve retusely umbonated; lateral areas scarcely distinguished; greenish-black, valves longitudinally painted in the middle with a brown band; ligament horny. (*Reeve.*)

Australia.

C. cunninghami RVE., Conch. Icon., t. 27, f. 181, Oct. 1847.—" *C. magnificus* Gray?" SOWB. Conch. Illustr., p. 2, fig. 52 (not described.)

The identity of the undescribed *C. magnificus* (Gray) Sowb. *non* Desh., with Reeve's *C. cunninghami*, is evident, the figures being extremely similar.

Carpenter gives the following notes on the type: " One specimen, marked by Baird (and rightly, I think) to be the same as *piceus* Rve. The valves are remarkably well grown, in quiet waters, and the sculpture is rather differently developed in consequence. The girdle has dried in around the valves, and the hairs are worn off except in the sutures, where they are short, crowded and black. Reeve's figure is very good except that the jugular parts appear too decided; they are simply worn smooth. The mucro is elevated, central, posterior slope convex; jugular area eroded; central areas wrinkle-granose, rugulæ radiating forward, more or less inter-

rupted into granules by wrinkles of increment; lateral areas scarcely defined. Divergence 127°.

The following is believed to be practically identical:

C. piceus Reeve. (Pl. 49, figs. 38, 39). Shell ovate, rather thick, valves concentrically flatly ridged, interstices between the ridges elevately striated and sometimes grained, umbos a little beaked; pitch-black, greenish on each side the umbonal summit; ligament horny, profusely beset with whitish short calcareous bristle-like processes. New Holland, on the rocks (Cunningham). This I believe to be the true *C. piceus;* it is a thick ponderous shell, of which the ligament, when in a good state of preservation, is covered with calcareous bristle-like processes, as in *C. spiniger* but much finer. (*Reeve.*)

Chiton piceus Reeve, Conch. Icon., t. 13, f. 70, March, 1847.—Angas, P. Z. S. 1867, p. 223.—Tapparone-Canefri, Zool. Viag. Magenta, Malacologia, p. 77 (1874).—*C. obesus* Shutt., Bern. Mittheil. 1853, pp. 67, 79.

Angas says that this species is freely distributed on most parts of the coast of New South Wales. The specimen commented upon by Canefri was collected at Sydney; but both may be founded upon wrong identifications. Carpenter writes of the types as follows: "Four specimens from Australia. The figure of Reeve is much larger than the type, and would stand well for a perfect *cunninghami*. The largest shell measures: length 77½, breadth 49 mill., divergence 108°. This is a more raised shell than *cunninghami*, probably from its having grown in rougher water. Spines very short, black, sometimes white. Sculpture almost entirely worn away in all the specimens; when seen it consists chiefly of concentric wrinkles more or less broken into granules. The lateral areas are scarcely distinguishable; mucro very perfect, post-median like *cunninghami*, but rather more elevated, as is the rest of the shell."

Subgenus Maugeria Gray, 1857.

Maugeria Gray, Guide Syst. Dist. Moll. Brit. Mus., p. 183 (in part).—*Acanthopleura* Carpenter, Table Reg. Chit. 1873, and Dall, Proc. U. S. Nat. Mus. 1881, p. 284, 289, 290 (in part); Not *Acanthopleura* Guilding, *q. v.*

Exterior lusterless; tail valve having numerous (7–12) slits in the short crenulated insertion-plate, median valves 1-slit, the exposed coating or tegmentum wider than the articulamentum or inner layer;

sinus not toothed, the sutural plates connected across it; girdle thick, densely beset with calcareous spinelets. Type *Ch. granulatus* Gmel.

This subgenus or section differs from *Acanthopleura* and *Mesotomura* in the shorter, blunt tail insertion-plate, and the proportionate breadth of the outer and inner layers of the median valves. It differs from *Amphitomura* in having numerous equally developed slits in the insertion-plate of the tail valve.

A. GRANULATA Gmel. Pl. 50.

Shell oblong, moderately elevated or roundly arched. Surface almost always eroded, dull, ashy or cinereous, generally with a patch of dead-leaf brown on the ridge of each valve; when not eroded, it is tawny-brown or black-brown, with a pair of diverging whitish, buff or pinkish stripes.

The valves are beaked, solid and thick, with somewhat raised but ill-defined lateral areas. When not eroded, the lateral areas and pleura are closely granulated all over, and the end valves likewise; but this sculpture is generally preserved only at the lateral extremities and the protected anterior margin of each valve. The mucro is swollen and posterior.

Interior sea-green, often varying toward lead-blue, or on the sutural-plates fading to nearly white; *each median valve having a black or purple-black tract between the sinus and the summit of the callus, this tract being square or 2-branched at the ends.* Anterior valve having normally 8–10, central 1 (rarely 2), posterior valve 9, (occasionally 7–14) slits; teeth long and very deeply pectinated outside; *teeth of tail-valve short and obtuse, directed forward, very deeply pectinated outside and on the edge.* Sinus slightly concave, or convex and notched at the sides, not denticulate.

Girdle thick and fleshy, densely covered with short, unequal spinelets (pl. 50, figs. 40, 41, x 13) which are short, calcareous, and either black or white; the black spines (fig. 41) being frequently longer than the white, and straight or nearly so; the white spines (fig. 40) are short, very unequal and shaped like the shell of *Cadulus*.

Bermuda; Bahamas; Charlotte Harbor, Vaccas Key, etc., west Florida; entire West Indies, southward to Trinidad and the Spanish Main.

Chiton magellanicus GMELIN, Syst. Nat. xiii, no. 12, p. 3204. (=Chemn. viii, p. 279, pl. 95, f. 797, 798, *Chiton magellanicus*).—

Wood, General Conchol., p. 18, t. 3, f. 6 (1815).—*Chiton granulatus* Gmel., *l. c.* no. 16, p. 3205 (=*Die pechschwarze granulirte Chiton* Chemnitz, Conchyl. Cab. viii, p. 284, t. 96, f. 806).—Wood, Gen. Conch., p. 9.—d'Orb., Moll. Cuba (Ramon de la Sagra, Hist.), ii, p. 200 (1853).—*Chiton piceus* Gmel., *l. c.* no. 17, p. 3205 (Chemn. viii, p. 285, t. 96, f. 807–810).—Wood, Gen. Conch., p. 8, t. 1, f. 3.—Sowerby, Conch. Illustr. f. 147.—Shuttlw., Bern. Mittheil. 1853, p. 78, and of most later writers on the Antillean fauna.—*Chiton occidentalis* Reeve, Conch. Icon., t. 14, f. 77a. (1847).—*Chiton salamander* Spengler, Skrivter af Naturhist. Selskabet, iv, p. 80 (= Chemn. viii, f. 806.—*Chiton tuberculatus* L., Schroeter, Einleit. iii, p. 494, t. 9, f. 19 ("Der cylindrische Chiton"); not *C. tuberculatus* Linné.—*Chiton unguiculatus* Blainville, Dict. Sc. Nat. xxxvi, p. 544.—*C. convexus* Blainv. *l. c.*—*Chiton* (*Acanthopleura*) *blauneri* Shuttl. Journ. de Conchyl. 1856, p. 170.—? *C.* (*A.*) *mucronulatus* Shuttl., Bern. Mittheil. 1853, p. 79.

This species is the common *Chiton* of the West Indies, being abundantly distributed throughout the group, the specimens before me being from the following localities: Bermuda (Heilprin); Key Vaccas, Florida (Calkins, Hemphill); Bahamas (H. C. Chapman, J. J. Brown, F. Stearns); Jamaica (Johnson and Fox); San Domingo (Gabb); St. Thomas (Swift); Dominica (Sharp) Monos, (Sharp); Atlantic coast of Costa Rica (Gabb). The specimens are almost always eroded, the original color and sculpture being quite lost. Although the species is very variable, no local forms deserving varietal rank are known to me.

Figures 39–41 represent a St. Thomas specimen, eroded in the usual manner. Fig. 48 is also drawn from a St. Thomas specimen in which the sculpture is perfectly preserved, and the color uncommonly dark.

Figures 44–47 represent valves of examples from St. Domingo. The non-eroded forward part shows a central brown band, with a flesh-colored band on each side of it. This coloring is also found in most specimens from Florida Keys (fig. 43), Jamaica, St. Thomas. Specimens from the Bahamas have the two light stripes blue-white, and are strongly corrugated.

The tail-valve varies greatly in respect to the prominence of the mucro. In some specimens (fig. 46) it projects beyond the posterior edge of the valve; in others it hardly attains the edge; but these variations do not seem to be correllated with other characters.

The identity of *C. magellanicus* Gm. and Chemn. with the West Indian species, although extremely probable, cannot be regarded as absolutely established. At all events the name is hardly acceptable, for no *Acanthopleura* of this type has been collected at or near the Strait of Magellan. Rochebrune's citation (Moll. Cap Horn) is worthless, on account of his ignorance of generic and specific characters in this group, and his false synonymy in the case of this species. Gmelin's *C. granulatus*, the next name in order of priority, was founded upon specimens from St. Thomas excellently described and figured by Chemnitz. The identity of the next form described by Gmelin, *piceus*, is also moderately sure. Reeve's *C. occidentalis* (see pl. 50, fig. 42) is an ordinary form of *granulatus*.

Shuttleworth has described two West Indian Acanthopleuras of which I have not seen authentic examples. His descriptions here follow:

C. (*Acanthopleura*) *mucronulatus*. Shell oblong-ovate, elevated, narrowed in front, black-brown, unicolored; valves all over very minutely concentrically punctate-striate, carinated dorsally, produced backward in a short apex; lateral areas slightly elevated. Girdle spotted with white, having scattered very minute, sand-like grains. Length 9, breadth 6 mill. Porto Rico, Blauner! Described from a single specimen; distinguished from the young of *granulata* by the form and especially the very minutely sanded girdle. Shell inside dull whitish, slightly greenish.

This may prove to belong to some other group. *C.* (*Acanthopleura*) *blauneri* Shuttl. was founded on a single black-brown specimen from Porto Rico, having unicolored black girdle densely clothed with very minute spines, more minute than in *piceus*, from which *blauneri* also differs in being more depressed and more minutely sculptured. Length 52, breadth 32 mill. I do not see that this falls outside of the well understood range of variation of *A. granulata*.

The following unfigured form may prove to be a distinct species if the locality be confirmed.

Chiton (*Acanthopleura*) *piceolus* Shuttl. Shell ovate, wider behind; obscure olivaceous, maculated with black at the middle of the back and at the sides; valves all densely and minutely pustulose-granulate; areas entirely obsolete. Girdle minutely and very densely sandy-spinulose, alternately maculeated brown and white. Length 10, breadth 6 mill. (*Shuttl.* Bern. Mittheil. 1853, p. 82.)

Tenerife, Canaries, (Blauner); rather common.

Intense black-green inside. Color, pattern and sculpture are as in young *C. piceus* Gmel., but it differs in the much smaller, more delicate girdle spicules. (*Shuttl.*)

Subgenus AMPHITOMURA Pilsbry, 1893.

Amphitomura PILS., The Nautilus, Jan., 1893, p. 105. Type *Ch. borbonicus* Dh.

Girdle and all valves but the eighth formed as in *Maugeria.* Tail valve having the insertion-plate very short, with blunt, crenulated edge, and a single shallow oblique slit on each side, and sometimes some uneven serrations in the middle.

The Mopaloid slits of the tail-valve are very peculiar, but the structure is fore-shadowed in some forms of *Maugeria.*

A. BORBONICA Deshayes. Pl. 45, figs. 76, 77, 78, 79.

Shell oblong, rather elevated, solid, roundly arched, dull *black with a white stripe on each side of the median black band;* rusty blackish and gray when eroded; girdle black.

The lateral areas are but slightly raised, and are *densely, finely sculptured with close radiating rows of granules;* the sides of the central areas are also granulated adjacent to the lateral areas, but toward the middle this sculpture disappears, leaving only a faint microscopic granulation. End valves radially, densely, granulated, the mucro posterior, rather elevated.

Interior *blue-white, each median valve having a broad black square-ended crescent in front of the callus,* the inflexed posterior margin ashy-olive, lateral triangles lead-white. Sinus deep, rounded. Anterior valve having 10, central valves 1, posterior valve 2 slits (figs. 76, 77); teeth pectinated, those in the front of the head-valve short. Eaves wide, black, channelled along the teeth. Muscle impressions on sutural plates and end valves deep.

Girdle fleshy, black, covered with black spinules about 1½ millim. long.

Length 50, breadth 30 mill.; divergence about 125°.

Mauritius; Reunion.

Chiton borbonicus DH., Moll. Réunion, p. 37, t. v, f. 12, 13.—*C.* (*Acanthopleura*) *borbonicus* Dh., MARTENS in Möbius' Reise nach Mauritius, p. 300.—? ? *Chiton nebulosus* WOOD, Index Test. Suppl., t. 1, f. 4.

Readily recognized by the black, granulated sides, and smoother two-striped ridge, in connection with the peculiar insertion-plate of the tail valves. Smith has placed the species with doubt in the synonymy of *A. spiniger*, where it certainly does not belong; and Martens, also erroneously, suggests its identity with *Ch. petholatus* Sow.

The insertion-plate of the tail-valve, while in some specimens somewhat uneven, is not often so serrated as in *A. brevispinosa*. It further differs from that species in the striped back and the interior coloration. The crescent-shaped black patch behind the sinus inside is square or forked at the ends, as in *A. granulata*, and the edge of the sinus is white.

A. BREVISPINOSA Sowerby. Pl. 47, figs. 18, 19, 20, 21.

Shell oblong oval, *depressed*, each valve beaked and concentrically rugose-granulated. *Color black*, the girdle narrow, clothed with *white-tipped black spinelets.*

The valves concentrically wrinkle-grained at the sides of the central areas, and the ill-defined lateral areas are *cut into granules by concentric and radiating grooves. End valves finely grooved radially, finely wrinkled concentrically;* mucro posterior, prominent and rather acute.

Interior *blackish-brown or purple-brown* except the sutural- and insertion-plates which are white. Sinus broad, deep, rounded. Anterior valve having 7–8, central 1, posterior 2 slits and a number of irregular serrations; anterior teeth moderately long, finely pectinated outside; *posterior teeth very short, blunt*, obsoletely pectinated.

Girdle rather narrow, clothed with rigid black spinelets tipped with buff.

Length 42, breadth 26 mill.; divergence about 130°.

Johanna, Comoro Is. (Cuming, Cpr.); *Zanzibar* (Cpr.); *Cape of Good Hope and Madagascar* (Paris Mus.); *Strait of Saint Vincent, Cape Verde Is.* (Cessac.)

Chiton brevispinosus SOWB., Mag. of Nat. Hist. 1840, p. 287, t. xvi, f. 1; Conchol. Illustr., f. 136.—REEVE, Conch. Icon., f. 52.—*Acanthopleura brevispinosa* ROCHEBR., Nouv. Arch. du Mus. 1881, p. 240.

Part of the localities given above are probably incorrect. A good many shells procured at "Cape of Good Hope" and "Zanzibar"

never grew at those places. The evidence in favor of the Comoro Is. is more satisfactory.

This species is closely allied to *A. borbonica* in sculpture, but it differs in having flatter, thinner valves, longer, white-tipped spines, in lacking the white dorsal stripes as well as in the color of the interior. Finally, the characters of the tail insertion plate differ.

Subfamily LIOLOPHURINÆ.

Median and anterior valves provided with eyes, and having well-developed insertion-plates with slits, the teeth pectinated outside, not thickened at the edges of the slits. Posterior valve with the mucro posterior and terminal; its insertion-plate obsolete, reduced to a low ridge or flat ledge of callus, which is unslit (except in *Schizochiton*) and continuous posteriorly or interrupted in the middle by a caudal sinus. Gills as long as the foot.

This group is closely allied to *Chitonidæ* and has doubtless been derived from the Tonicioid branch of that stock. It is separated from them on account of the degeneration of the posterior valve and especially its insertion-plate,—a character of vastly less importance than Carpenter supposed. The median notching of the tail valve behind is also extremely variable, as is exemplified by such closely allied forms as *Lorica volvox* and *L. angasi*. All of the genera of *Chitonidæ*, *Chiton*, *Eudoxochiton*, *Tonicia* and *Acanthopleura*, show species in which the tail valve has an incipient caudal sinus, or in which the insertion-plate is becoming obsolete, or both conditions. It is only necessary to mention *Chiton jugosus* (p. 178), *Eudoxochiton* (pp. 193, 194), *Tonicia confossa* (p. 210); *Acanthopleura spinigera*, all showing more or less posterior emargination; *Acanthopleura granulata* and the section *Amphitomura* have the posterior insertion-plate very short, some forms of the latter having it nearly deprived of slits. Compare with these *Schizochiton* and *Lorica*, the latter having the insertion-plate short but distinctly crenulated. It is probable that deposits not older than Miocene will furnish the generic links now missing between the series of forms here included in *Toniciinæ* and those grouped in *Liolophurinæ*.

It is a notable fact that the generic groups of *Toniciinæ* and *Liolophurinæ* seem to mutually correspond to one another, as though the several generic stocks of the former subfamily had been simultaneously modified in the same manner, thus:

Toniciinæ.		Liolophurinæ.
Tonicia	Eyes disposed in radiating bands; valves polished and bright colored outside, porcellanous within; girdle leathery, nude.	*Onithochiton.*
Maugeria	Eyes scattered among the tubercles of the surface, which is rough and lusterless; interior dark; girdle clothed with calcareous spines.	*Liolophura.*
Mesotomura	Eyes very minute, oval, scattered; surface of valves brown and polished outside when not eroded, peculiarly sculptured inside.	*Enoplochiton.*

The genera *Lorica* and *Schizochiton* have no representatives in the *Toniciinæ*, for while they are closely allied to the latter, they have been differentiated along a line away from that taken by *Onithochiton* and its immediate allies.

Synopsis of Genera.

A. Median valves having eyes developed only on the diagonal ribs. Sinus notably narrow and small. Insertion-plate of tail valve a low, rounded, rugose ridge more or less notched or waved upward in the middle behind, or sharp, long and pectinated.

B. Eyes large, situated on the diagonal ribs and on the ribs of the head valve, the latter corresponding to slits in the insertion-plate. Girdle having minute calcareous spines.

Genus XVI. SCHIZOCHITON Gray.

Much elongated. Posterior valve having a deep caudal sinus with one or two notches on each side of it in the insertion-plate. Head valve with few (about 6) slits. Girdle sparsely, finely spinulose, slit behind.

BB. Eyes reduced to minute, functionless punctures on the summit of the diagonal ribs, and entirely absent on the head valve, the riblets of the latter not corresponding to internal slits. Girdle densely scaly.

Genus XVII. LORICA H. & A. Adams.

Oval or ovate, elevated. Posterior valve having a deep caudal sinus or a shallow wave, the insertion-ridge otherwise uninterrupted.

Head valve with numerous (8–10) slits. Girdle densely clothed with minute, convex, crowded scales.

Section LORICA s. str. Caudal fissure deep; sinus v-shaped; girdle widest at the sides, slit behind.

Section LORICELLA Pils. Caudal fissure reduced to a shallow wave; sinus bilobed; girdle widest in front, not slit behind.

AA. Eyes developed upon the lateral areas. Sinus wide and large. Insertion-plate of the tail valve reduced to a smooth ledge or ridge, having no posterior sinus or wave.

Genus XVIII. ENOPLOCHITON Gray.

Valves polished or deeply eroded, dark brown outside and within, having excessively minute eyes scattered over lateral areas and head valve (when not eroded); interior very densely and minutely and peculiarly grooved and punctured. Girdle fleshy, bearing separated rude scales.

Genus XIX. ONITHOCHITON Gray.

Valves polished, colored outside, porcellanous and smooth within, having the eyes disposed in radial bands on each lateral area and the head valve. Girdle leathery, microscopically velvety.

Genus XX. LIOLOPHURA Pilsbry.

Valves lusterless, granulated, having the minute eyes scattered over the lateral areas, sides of the central areas and head valve. Girdle densely covered with stout calcareous spines.

Genus XVI. SCHIZOCHITON Gray, 1847.

Schizochiton GRAY, P. Z. S. 1847, pp. 65, 68, 169.

Valves exposed, elongated, beaked, bearing a single row of eyes upon each diagonal rib of intermediate valves and each radiating rib of the head valve, the ribs of the latter corresponding in position to slits in the pectinated insertion-plate. Sinus narrow. Posterior valve having a deep posterior fissure, and several slits on each side of it. Girdle slit behind, bearing small calcareous spinelets. Type *Ch. incisus* Sowb.

This genus might as readily be referred to *Toniciinæ* as to *Liolophurinæ*, for the posterior insertion-plate is well developed. The

posterior sinus, however, is unlike the former group, in which the tail valve approaches the head valve in form; and the arrangement of the eyes is the same as in *Lorica*, which has a degenerate tail insertion-plate. At the same time, it must be granted that the differences between *Schizochiton* and *Lorica* are greater than between most genera of the same family; for in *Schizochiton* the slits of the head-valve are numerically related to the external ribs; the latter bear eyes, and the tail valve has a well developed slit and pectinated insertion-plate.

S. INCISUS Sowerby. Pl. 51, figs. 1–8.

Shell *much elongated*, narrow, the valves elevated, somewhat carinated; surface lusterless, grayish, obscurely mottled with olive and purplish.

Median valves elongated, beaked, the *lateral areas small*, slightly raised. *Entire surface sculptured with flattened longitudinal riblets, as wide as their interstices, converging toward the dorsal ridge and somewhat irregular or wavy on the lateral areas; each riblet where it passes over the diagonal, enlarged for the insertion of an eye.* Anterior valve (figs. 2, 4) having 6 (sometimes 7 or 8) radiating curved ribs, each bearing a series of eyes, the intervals sculptured with close v-shaped riblets. Posterior valve (figs. 6, 7, 8) having the mucro posterior, the latero-posterior areas tricostate, otherwise sculptured like the median valves; *posteriorly it has a wide, deep fissure, extending up to the mucro* (fig. 8.)

Interior whitish, stained with purple-brown in the middle of each valve. Sutural plates well developed. *Sinus V-shaped.* Anterior valve having 6, central valves 1 or 2 slits; posterior valve, on each side of the posterior fissure, 3 slits; teeth thin, distinctly crenulated outside.

Girdle broad, alternately buff and dark colored, the light stripes wider, and as usual, sutural; rather thinly but in places densely clothed with minute, cylindrical, shelly spinules, part brown, part white. Length 50, breadth 18 mill.

Zebu, (Cuming), *and Samboangan*, (Challenger), *Philippines; Raines Island, Torres Straits* (Ince); *Clairmont and Bird Is., N. E. Australia* (Coppinger); *Sulu Sea* (Capt. Chimmo.)

Chiton incisus SOWB., P. Z. S. 1841, p. 61.—REEVE, Conch. Icon. f. 43.—*Schizochiton incisus* GRAY, P. Z. S. 1847, p. 169.—SHUTTL., Bern. Mittheil. 1853, p. 68.—H. & A. AD., Gen. Rec. Moll. i, p. 477,

t. 54, f. 6, 6a.—Smith, Zool. Coll. H. M. S. 'Alert' p. 82.—Haddon, Challenger Polyplac. p. 31.—Moseley, Journ. Roy. Microscop. Soc. xxv, p. 37, pl. iv, figs. 1–5; vi, f. 5 (eyes).—*Chiton elongatus* Reeve, Conch. Icon., f. 40.—*Schizochiton polyophtalmus* Rochebrune, Bull. Soc. Philomath. de Paris, 1881–'82, p. 191.

This species is so unlike other forms that comparisons are unnecessary. The eyes are larger than in any other form known to me. A single eye is shown in fig. 3, magnified 200 diameters.

The girdle is not well shown in fig. 1, the spines being too evenly distributed over it. They are always closer at the sutures.

Genus XVII. LORICA H. & A. Adams, 1852.

Lorica H. & A. Ad., Annals and Magazine of Natural History, (2) ix, p. 355 (April, 1852). Only species *L. cimolia*, *Chiton cimolius* Rve.—*Aulacochiton* Shuttl., Bern. Mittheil. p. 68 (June, 1853), type *Chiton volvox* Reeve.

Valves exposed, not beaked, the lateral areas and end valves with many fine riblets or pustules. Eyes confined to a single series along the summit of each diagonal rib. Insertion-plates blunt, obsoletely pectinated, the slits in head-valve not corresponding to external ribs; sinus very small. Posterior valve having the mucro posterior and terminal, insertion-plate unslit, obsolete, being reduced to a convex ridge of callus; posteriorly cleft to the mucro by a deep rounded sinus, or waved. Girdle slit or waved behind, densely scaly.

This is one of the few genera of "irregular" Chitons having a scaly girdle. The eyes seem to be nearly obsolete, and possibly are not functional, although they still are pigmented. In most specimens a good hand-lens shows the series of ocular punctures along the diagonal ridge, immediately in front of the anterior row of pustules.

The non-correspondence between slits and external ribs, the scaly girdle, the transverse, unbeaked valves and the toothless posterior insertion-plate, are all characters widely sundering this genus from *Schizochiton*.

Section *Lorica s. str.*

Sinus in tail valve deep; jugal sinus v-shaped; girdle widest at the sides, cleft behind.

L. VOLVOX Reeve. Pl. 52, figs. 14–21.

Shell oblong, *strongly elevated*, the dorsal ridge angular, side-slopes nearly straight. Surface lusterless, finely sculptured, variable in color; sometimes buff with chestnut streaks and darker angular blotches on the central areas, fewer on the lateral areas; sometimes the lateral areas are olive-green, the dorsal region light, the sides of the central areas brown or olive. The dorsal ridge is sometimes stained with orange on each valve, and the same color often clouds the sides also.

The median valves are *not beaked*, even when young, but they are falsely beaked or narrowly projecting at the sinus in front. Lateral areas raised, sculptured with 8–12 low radiating cords bearing rounded pustules, which are more or less entirely lost in adult specimens. Central areas sculptured with numerous narrow raised threads parallel to the dorsal ridge, their interstices wider than the threads, and closely latticed across. Anterior valve strongly elevated, *curving forward at the summit, the anterior slope being concave;* sculptured with many radiating riblets which are pustulose when not eroded. Posterior valve small, much depressed, with *posterior, terminal, elevated mucro;* posterior-lateral margins bounded by an elevated rib; posterior area extremely small, vertical, perpendicularly ribbed, *having a deep rounded excavation behind.*

Interior white; tegmentum reflexed and sculptured along the posterior margin of each valve; sutural-plates broad, separated by *an extremely small* v-*shaped sinus* in the middle. Anterior valve having 8, central 1 slit; slits minute; teeth short, blunt, finely but obsoletely pectinated outside, and crenulated on the edge. Posterior valve having a low, rounded callus ridge in place of the insertion-plate, its edge unslit, finely and rather obsoletely striated, interrupted by a deep rounded sinus in the middle behind. Eaves narrow, solid.

Girdle wide, bluish with inconspicuous dusky cross bars, slit behind, its surface very densely covered with minute, closely imbricating smooth convex scales (fig. 16.)

Length 70, breadth 38 mill.; divergence about 90°, the young more depressed.

Port Jackson, Sydney, Watson's Bay and Middle Harbor, N. S. Wales; Port Lincoln, S. Australia, under stones at extreme low tide.

Chiton volvox REEVE, Conch. Icon., t. 6, f. 31 (Feb., 1847).—*Lorica volvox* (Rve.) HADDON, 'Challenger' Polyplac., p. 31.—*Chiton cimolius* REEVE, Conch. Icon., t. 21, f. 141 (May, 1847).—*Lorica cimolia* H. & A. AD., Ann. Mag. N. H. (2) ix, p. 355.—ANGAS, P. Z. S. 1867, p. 224; 1871, p. 97.—*Aulacochiton volvox* SHUTTL., Bern. Mittheil. 1853, p. 68.—? *Chiton rudis* HUTTON (see below.)

The differences between *L. volvox* and *L. cimolia* are easily effaced when a good series is examined. The young show great variation in the pustulation of the lateral areas, the pustules sometimes being scattered, radiating, cords obsolete. The dorsal ridge generally has a central fine carina with a long narrow smooth triangle on each side, but this varies also. The second valve has a rather large median patch of scattered or diverging series of pustules. The coloring varies a good deal in the series before me.

I am disposed to consider Hutton's *Chiton rudis* a synonym of this species, but my opinion is founded upon a study of the original description only, which is as follows:

Chiton rudis Hutton. Oblong; margin with minute scales; valves elevated, flattened on the sides, not keeled; apex of anterior valve recurved, with its posterior margin slightly convex at the sides and deeply concave in the center; posterior margins of intermediate valves straight; posterior valve rather small; apex posterior, pointed and emarginate. Anterior valve and lateral areas with radiating moniliform ribs; posterior and median areas widely but rather irregularly, deeply longitudinally furrowed, with narrow ridges between Margin gray, with broad, irregular, reddish-brown transverse patches; valves grayish-brown; interior grayish-white. Length 1·75, breadth ·75 inch. Founded on a specimen in the Colonial Museum, locality not stated. (*Hutton*, in Trans. N. Z. Inst. iv, 1872, p. 179, and Man. N. Z. Moll. 1880, p. 113.)

Section *Loricella* Pilsbry.

Sinus in tail valve a mere wave; jugal sinus lobed; girdle widest in front, not cleft behind.

L. ANGASI Adams and Angas. Pl. 51, figs. 9–13.

Shell ovate, coarctate and angulate behind, pale brown, variegated with green. Anterior valve concentrically striated and having radiating pustulose ribs; posterior valve narrow, transversely sulcate and densely longitudinally lirate; median valves subcarinated, the

central areas densely lirate and transversely sulcated; the lateral areas elevated, radially lirate, the liræ pustulose.

Girdle moderate, olivaceous, beset with minute scales.

Length 40, breadth 26 mill. (*H. Ad. & Ang.*)

Rapid Bay, S. Australia (Angas); *Camp Cove, Port Jackson, N. S. Wales* (Brazier). In deep water.

Lorica angasi H. Ad. & Ang., P. Z. S. 1864, p. 193.—Angas, 1865, p. 187; 1871, p. 97.—*Aulacochiton angasi* Cpr., *MS.*

I have not seen this species, which is here figured for the first time, from drawings made by Emerton for Carpenter, who writes as follows:

"Anterior valve large; posterior valve small, the mucro terminal, much elevated, prominent; diagonal ridges elevated; dorsal ridge acute. Interior: posterior valve a little sinuated behind, the sinus wide; having two callous, subobsolete, slightly roughened ribs in place of the insertion-plates. Anterior valve with 10, central valves 1 slit; teeth acute, serrated outside and at the edge; eaves prominent, deeply grooved; sinus narrow, deep; the sutural plates separated, but having a lamina between them which is sometimes bilobate or denticulate. Girdle reduced one-half in width behind, and sinuated, very closely beset with solid minute scales, seen under a lens to be obsoletely bilobate.

Length 32½, breadth 22½ mill,; divergence 110°.

"One of Mr. Cuming's specimens is much broader and somewhat tripartite. This species differs from the typical *Lorica* in the anterior projection of the girdle; in the minute raised scales, which under the microscope look like grains of wheat set on end; in the sinus having a separate lamina, somewhat lobed; in the absence of anterior 'false apex' on the valves; and finally in the mucro being terminal and but slightly waved, with a correspondingly slight wave in the girdle behind."

The "hairs" shown on the girdle in fig. 9 are foreign to it.

Genus XIX. LIOLOPHURA Pilsbry, 1893.

Liolophura Pils., The Nautilus vi, p. 105 (January, 1893).—*Acanthopleura sp.*, of authors.

Valves exposed, dull and somewhat roughened, generally eroded outside, with minute eyes irregularly scattered over the lateral areas, the head-valve and the sides of the central areas. Interior dark

colored, having anterior and side insertion-plates slit into teeth and sharply pectinated outside; posterior valve with posterior terminal mucro, lacking the insertion-plate, which is represented by a flat callous ledge. Sinus wide, deep, smooth.

Girdle covered with stout calcareous spines or obtuse club-shaped processes. Type *Chiton japonicus* Lischke.

The species of this genus have been referred to *Acanthopleura*, *Maugeria* and *Chiton* by authors who have mentioned them; but from these groups the characters of the tail-valve at once sunder them. *Liolophura* resembles *Onithochiton* and *Enoplochiton* in having a callous ridge in place of the posterior insertion-plate, in the pectinated teeth of the other valves, and in the possession of eyes; but it differs from *Onithochiton* (*a*) in the somewhat *raised* instead of marginal mucro, (*b*) in the dullness of the valves externally, (*c*) in the distribution of the eyes upon the *sides of the central areas*, whilst in *Onithochiton* they occupy a band on the forward part of the lateral areas only; and finally (*d*) in the covering of the girdle which in *Liolophura* consists of densely crowded calcareous spines, comparable to the spines of *Maugeria*. *Liolophura* differs from *Enoplochiton* in lacking the interior sculpture and denticulate sinus characteristic of that genus, and in the totally diverse development of the girdle covering.

L. GAIMARDI Blainville. Pl. 53, figs. 30–35.

Shell oblong, depressed, roundly arched. Surface lusterless, buff-gray, marked at sides and on ridge of valves with black. Girdle tessellated light and dark, having a light bar opposite each suture, or having dark or light larger patches.

The valves are somewhat beaked, but always considerably eroded; lateral areas but little raised, concentrically wrinkled toward their bases, studded with minute scattered eyes appearing as black dots. Central areas wrinkled by lines of growth and having scattered eyes at the sides. Head valve concentrically wrinkled, studded with eyes. Tail valve small, depressed, similar in contour to the median valves, the mucro being posterior and terminal, but eroded.

Interior dark red-brown, whitish on the edges of the sutural-plates and the valve-callus; posterior internal margin covered by the reflexed blackish-brown tegmentum. Sutural-plates brownish below with a white outer edge; seen from above they are whitish shading into reddish-brown toward the median sinus; rounded, broadly separated by a very wide, deep, rounded sinus. Anterior valve hav-

ing 9, central valves 1 slit; the teeth deeply, closely pectinated outside. Posterior valve having the eaves projecting beyond the broad, flat crescent of callus which occupies the place of an insertion-plate.

Girdle densely clothed with intermingled minute, larger and large calcareous spines, (fig. 31.)

New South Wales (Wilkes); *Port Jackson* (Blainville, Coppinger and Challenger Exped.) *Australia.*

Chiton incanus GOULD, Proc. Bost. Soc. Nat. Hist. 1846, ii, p. 145; U. S. Expl. Exped., p. 315, t. 28, f. 432, 432*a*; Otia, p. 6.—*Maugeria incanus* GLD., Otia, p. 248.—*Acanthopleura incana* E. A. SMITH, Zool. Coll. H. M. S. 'Alert,' p. 81, 1884.—? *Chiton piceus* ANGAS, P. Z. S. 1867, p. 223.—*Acanthopleura* (*?*) *incana* (Gld.) HADDON, Challenger Polyplac., p. 25 (in part.)—*Chiton gaimardi* BLAINV., Dict. Sc. Nat. xxxvi, p. 546, (1825.)

This species may readily be separated from all forms of *Acanthopleura* by the peculiar flat callus of the tail valve inside, altogether lacking the pectination and slits which are present in *Acanthopleura.* It differs also in having eyes scattered over the sides of the lateral areas, and in having some of the girdle-spines striated. It differs from the Japanese species in the differently colored interior and sutural-plates, in the details of girdle-structure, etc.

The spines on the white tracts of the girdle are unicolored whitish; on the dark tracts they are of a uniform black-brown color. Occasional spines are striated like the scales of *Ischnochiton.*

L. GEORGIANA Quoy and Gaimard. Pl. 53, figs. 36–40.

Body oval, thick; girdle narrow, granulose, whitish with 8 white stripes; valves arcuate, flattened, thickly striated; brown, black in the middle.

The body is short, oval, much swollen; girdle very thick, little dilated at the sides, covered with very small rounded tubercles, white with 8 black bands across each side. Foot narrow, yellowish. Branchiæ reaching to the buccal fringe, which is large. Valves very wide, covering nearly the whole body, semicircular, but little elevated, narrowed, somewhat heart-shaped, very thick; having concentric striæ, the anterior and lateral most marked; of a deep brown color at the sides, lighter in the middle with a black dorsal line; fourth and fifth valves equal and wider than the others. Inside the valves are of a violaceous brown; median valves with an arcuate thickening. The sutural plates are short, rounded, separated by a flat, straight median sinus. Insertion plates slit and crenulated.

Anterior valve having 12 to 15 short, unequal, deeply striated teeth. Posterior valve triangular, flattened, with a callus in place of the insertion-plate. All of the apophyses (which are of a horny color) have a brown spot at the angle.

Length 19 lines, breadth 1 inch. (*Q. & G.*)

King George Sound, S.-W. Australia (Port du Roi-Georges.)

Chiton georgianus Q. & G., Voy. de l'Astrol., Zoologie, iii, p. 379, t. 75, f. 25–30.

This species is apparently still unknown in English and American collections. It seems to resemble closely the *L. incana* of New South Wales, but differs, if we may trust Quoy's account, in the much shorter girdle appendages, which resemble "rounded tubercles" rather than unequal spines. The figure of a detached valve given by Quoy shows a forward wave of the tegmentum at the median sinus, more prominent than in any *incanus* before me, which scarcely show such a wave except on the second valve. The median valves of *Enoplochiton niger*, however, present an exactly similar sinuosity of the margin (compare figs. 24, 25, of pl. 52). The sinus, moreover, appears in Quoy's figures to be bridged by a lamina connecting the sutural plates, a condition which does not obtain in *L. incana*. It is possible that the small variety mentioned by Quoy is more closely allied to the *incana*, or identical with it.

L. CURTISIANA Smith. Pl. 24, fig. 6.

I am disposed to believe that CHITON CURTISIANUS Smith, which is described on p. 97 and illustrated on pl. 24, fig. 6 (figure enlarged and inverted), is a member of this genus; but as Smith called it an *Ischnochiton*, I included it in that genus provisionally.

L. JAPONICA Lischke. Pl. 53, figs. 41, 42, 43, 44.

Shell oblong, moderately elevated, arched, not carinated. Surface lusterless, generally much eroded and encrusted; blackish, generally showing a wide light stripe on each side of the black dorsal stripe; the wide girdle olivaceous, not distinctly barred.

The median valves are beaked; lateral areas hardly raised, sculptured with concentric growth-wrinkles and a minute granulation, often lost by erosion. Central areas similarly sculptured. The forward half or two-thirds of the lateral areas and the outer portion of the central areas is black-dotted by the numerous irregularly scattered eyes. Anterior valve sculptured like the lateral areas and closely studded with scattered black dots (eyes). Posterior valve depressed,

the mucro posterior and terminal, being produced beyond and above the posterior eaves.

Interior black. The sutural plates are black both outside and within, and are widely separated by a broad, deep, rounded sinus. Head-valve with 8, 9 or 10, median valves 1 slit; teeth short in front, longer at the sides, deeply pectinated outside. Posterior valve having a broad flat crescentic callus in place of the insertion-plate.

Girdle very broad, densely clothed with short, obtuse black-brown spines, tipped with whitish (fig. 43.)

Length 50, breadth 20 mill. (measurements not including girdle.)

Japan, at Enoshima (F. Stearns); *Oosima* ('Challenger'); *Nagasaki* (Lischke.)

Chiton japonicus Lischke, Malak. Blätter, xxi, p. 22 (June, 1873); Japonische Meeres-Conchylien iii, p. 71, t. 5, f. 8–11.—*Maugeria japonica* Dkr., Index Moll. Mar. Jap., p. 158.—*Acanthopleura* (*?*) *incana* Haddon (in part), Challenger Polyplac., p. 25. Not *Ch. inconus* Gould.—*Ornithochiton caliginosus* Cpr., *MS.* (specimen described from China.)

? *Chiton De Filippii* Tapparone Canefri, Zool. del Viaggio intorno al Globo della R. Fregata 'Magenta,' Malacol., p. 77, 1874.

Distinguished from *L. incana* by the uniform black color of the inner layer or *articulamentum.*

The typical *japonica* (pl. 53, figs. 41–44) has a broad girdle, densely clothed with spinelets which are nearly or quite cylindrical, and are about equal in size over the entire area of the girdle. There are usually some dusky bars, especially toward the ends; and the individual spinelets are dark brown, tipped with light brown or cream-white.

Var. *tessellata* Pils. (pl. 53, figs. 45, 46) includes specimens agreeing with the type in valve structure and coloring, but having the girdle much narrower, and conspicuously varied with alternate patches of white and scorched-brown or blackish. The individual spinelets are larger than in typical *japonica*, and vary much in size, being small toward the outer edge of the girdle, large and flattened toward the inner edge. Upon the light tracts the spines are unicolored white; upon the dark tracts they are reddish-brown or blackish, unicolored or tipped with lighter.

Specimens collected by Stearns are before me, from Enoshima, where the typical form also is found.

The type of Carpenter's unpublished *Ornithochiton (?) caliginosus* is shown in figures 41–45 of pl. 54. It was described from specimens in the Cuming collection from "China Seas," and C. B. Adams collection from Hongkong. I have no doubt of its identity with the *L. japonica*. The latter had not been published at the time Carpenter wrote his diagnosis.

Tapparone Canefri's note on *Ch. defilippii* is not sufficiently clear for me to quote it without the mark of interrogation; for he compares with a species from Sydney which he calls *Chiton piceus* Gmel. But although he refers to Reeve, fig. 70, I am disposed to believe from his text, that what he really had from Sydney was *Liolophura incana* Gld. In this case, there can be little doubt that his *defilippii* is a synonym of *L. japonica*.

L. LOOCHOOANA Broderip & Sowerby.

Valves subscabrous, the marginal areas radially granose. Girdle leathery, granose above, the grains elevated. Length 18¾, breadth 7¾ mill. A very pretty little Chiton, whose margin is covered with small grains, resembling very short, blunt spines. (*Brod. & Sowb.*)

Shore of Loo Choo Is. (Belcher, Mus. Zool. Soc. Lond.)

Chiton loo-chooanus BROD. & SOWB., Zool. Journ. iv, p. 368 (Oct. 1828—Jan., 1829.)

This species is absolutely unrecognizable by the above description, but it was perhaps a member of the genus *Liolophura* which the authors had before them. It is not mentioned or illustrated in the "Zoology of Captain Beechey's Voyage." See Gray's reference to these descriptions in the "Introductory Remarks," Zool. Beechey's Voy., p. 103.

Genus XIX. ONITHOCHITON Gray, 1847.

Onithochiton GRAY, P. Z. S. 1847, p. 65, 68.—*Onythochiton*, GRAY, *l. c.*, p. 169 (type *Ch. undulatus*); Guide Syst. Dist. Moll. B. M., p. 184.—*Ornithochiton* CPR., in Dall, Proc. U. S. Nat. Mus. 1881, p. 284.

Valves exposed, polished, beaked, with indistinct lateral areas; eyes present and disposed in a ray on the forward part of each lateral area and in numerous rays on the anterior valve. Interior porcellanous; sinus denticulate, angular; insertion-plates pectinated

outside, that of the first valve with 8 slits, median valves 1 slit; posterior valve depressed, triangular, with posterior terminal and marginal mucro, the insertion-plate reduced to a low, smooth and narrow callus. Girdle leathery, rendered velvety by very minute chaffy hairs. Type *O. undulatus* Quoy.

This genus resembles *Enoplochiton* and *Liolophura* in the characters of the tail valve. It differs from the former in the unsculptured, porcellanous interior, much more delicate structure of the tail-valve callus and different type of girdle. *Onithochiton* differs from *Liolophura* in the texture both inside and out, the very different arrangement of the eyes, more delicate tail-valve callus, and in the characters of the girdle.

The species are distributed from the Cape of Good Hope to New Zealand.

Carpenter emended the name to "Ornithochiton" believing it to be derived from *ornis, ornithos,* in allusion to the resemblance of single valves to the conventional representation of a bird on the wing; but if any Greek root was in Gray's mind it was probably *Onychochiton* rather than *Ornithochiton.*

Key to species of Onithochiton.

a. Lateral areas and anterior valve smooth or radially sculptured; central areas smooth.

b. Lateral areas smooth or with 4 or 5 low subgranose riblets, *undulatus.*

bb. Lateral areas closely sculptured with close, subgranose striæ, *semisculptus.*

aa. Lateral areas having concentric sculpture; central areas or pleura with forwardly-converging sulci.

b. Length of posterior valve from sinus to mucro distinctly less than half the valve's breadth, *lyellii, quercinus, rugulosus,* [*amicorum.*

bb. Length of posterior valve from sinus to mucro half the valve's breadth.

c. Valves having a smooth dorsal triangle, *maillardi.*

cc. Valves having zigzag sculpture over the ridge, *literatus.*

O. UNDULATUS Quoy & Gaimard. Pl. 55, figs. 14, 15, 16.

Shell oblong, moderately elevated, the dorsal angle rounded, side-slopes nearly straight. Surface polished; color either (1) olive-buff

or olive-gray, becoming yellow toward the apices of the valves, each valve elegantly painted throughout with concentric olive or brown lines, and having a darker dorsal band; or (2) olive-green at the sides, with a broad light triangle on the ridge of each valve, in the middle of which there is a stripe of rich chestnut or of green; the whole concentrically lineolate with irregular green and cream-white lines.

The valves are beaked; lateral areas but little raised, *and either smooth or sculptured with* 4 *or* 5 *low, more or less obsolete, beaded radiating riblets;* and showing under a lens, a band of eye-dots near the front margin. *Central areas smooth and polished.* Anterior valve having obsolete radiating riblets, and rays of eyes, the eye-rays variable in number, width, and degree of coalescence, the individual eyes being very mutable in number and position. Posterior valve very shortly subtriangular, the distance from sinus to mucro being but little more than one-third the width of the valve's tegmentum.

Interior white, marked with reddish-brown under the beak in each valve. Sinus delicately toothed, deep and angular; sutural-plates higher toward the sinus than toward the outer edges of the valves. Anterior valve having 8 slits, median valves 1 slit; teeth obtuse, closely and sharply pectinated outside and on the summits. Posterior valve having a narrow, slightly convex ridge in place of the insertion plate.

Girdle reddish or brown.

Length 25, breadth 16 mill.; divergence 110°.

Length 27, breadth 14 mill.; divergence 110°.

New Zealand, at Bay of Islands (Q. & G.); *Auckland to Dunedin* (Hutton); *Chatham Is.* (Hutton.)

Chiton undulatus Q. & G., Zool. Astrolabe, p. 393, t. 75, f. 19–24. —Reeve, Conch. Icon., t. 16, f. 87, 90.—*Onithochiton undulatus* Ads., Genera, i, p. 476, t. 54, f. 3.—*Tonicia undulata* Hutton, Man. N. Z. Moll., p. 114 (1880.)

The comparative breadth of this species is subject to considerable mutation, as well as the coloring and the development of weakly beaded riblets on the lateral areas. In some specimens these riblets are not perceptible. Occasionally the sides of some valves are uniform greenish, lacking brown lines and angular white lines.

This species has been reported from Tasmania, but on insufficient authority.

The sculpture in this form differs markedly from the Australian and S. African species.

O. SEMISCULPTUS Pilsbry, n. sp. Pl. 55, figs. 10, 11.

Shell oblong, elevated, subangular, dark olive-green, having snowy angular lines and dots on the lateral areas, and closer, more regular transverse lines on central areas. *Surface shining and smooth on the central areas, closely and finely striated radially on the head valve and lateral areas, the striæ crowded and subgranose,* about 12 in number on each lateral area. Interior white. Girdle narrow, brown.

Length 27½, breadth 16 mill.; divergence about 95°.

Habitat unknown.

This species resembles the stout, elevated, dark olive forms of *O. undulatus,* such as occur at Auckland, N. Z., in contour and coloration. It differs markedly from *undulatus* and all other known species in the sculpture of the lateral areas.

Figure 10 shows two half valves, the upper illustrating the color-pattern, the lower the sculpture.

O. LYELLII Sowerby. Pl. 55, figs. 1–7.

Shell oblong, moderately elevated, the dorsal ridge rounded or slightly subangular. Color extremely variable; typically green at the sides, with a tessellated black or chestnut dorsal stripe in the middle of a pink-dotted area; but other specimens are blotched with green at the sides with concentric creamy lines and a creamy area on the ridge of each valve, along which runs a band of dark chestnut spots often on a bluish ground. Occasional specimens have a large black blotch on the sides of some valves.

The median valves are beaked. Lateral areas a trifle raised, *sculptured with rather uneven concentric shallow grooves* with rather wide, flat interspaces; near the front edge of each lateral area there is a narrow band of minute eye-dots. *Central areas sculptured at the sides with fine, close grooves* (continued from those of the lateral areas) converging toward the ridge, where there is a narrow smooth dorsal band. Anterior valve having about 10 narrow rays of eyes, the spaces between sculptured with concentric grooves interrupted by the eye-bands into scallops having their convexity upward. Posterior valve broadly triangular, depressed.

Interior white with a crimson spot in the cavity of each valve. Sinus deep, angular, delicately subdenticulate. Anterior valve having 8, median 1 slit; the teeth rather long, sharply pectinated out-

side. Posterior valve having a smooth callus in place of the insertion-plate, separated from the eaves by a groove at each side.

Girdle leathery, closely clothed with microscopic down, clouded brown and whitish.

Length 42, breadth 20 mill.

Pitcairn Island, in small hollows, at low water mark (Cuming); *Raine's Island, Torres Sts.*, under stones at low water (Ince); *Watson's Bay, N. S. Wales, Australia*, at very low tides (Angas.)

Chiton lyellii SOWB., P. Z. S. 1832, p. 26: Conch. Illustr. f. 7.—REEVE, Conch. Icon., f. 12.—*Chiton incii* REEVE, Conch. Icon. no. 94, t. 16, f. 96; detail fig. 94.—*Chiton puncticulatus* REEVE, Conch. Icon., t. 13, f. 69*b* and description in part—*Onithochiton incei* ANG., P. Z. S. 1867, p. 223.

This species differs from *O. maillardi* in the narrower smooth dorsal areas, the less deep, less regular grooving of the lateral areas, and the shorter and broader posterior valve. It relations to the following species are not clear to me, as I have seen no authentic specimen of the latter.

Figs. 8, 9 of pl. 55 represent the *C. incii* of Reeve.

The *Chiton puncticulatus* of Reeve seems to have been founded on a specimen of this species and one of *Pallochiton lanuginosus*; but Reeve's reference to the punctation seems to apply best to this form. In any case, the name is so ill-defined that it cannot in fairness be used.

O. QUERCINUS Gould. Pl. 55, figs. 12, 13.

Shell small, depressed, slightly carinate and beaked, ovate, yellowish wood or oak color, clouded with olive or dusky slate color at the sides. Lateral areas scarcely raised, but distinctly marked by coarse longitudinal sulci, which are divided by a radiating furrow and sometimes more, and the two portions form somewhat of an angle with each other; central areas with faint, rugose, longitudinal lines toward the margin, and scattered punctures about the apex; anterior valve checked with raised spaces formed by concentric and more distant radiating furrows, which become more numerous near the margin; posterior valve with the umbo nearly terminal, so that the transverse ridge runs nearly parallel to the margin. Marginal ligament broad, yellowish, frosted. (*Gld.*)

Length 22, breadth 15 mill.

New South Wales, Australia.

Chiton quercinus GLD., Proc. Bost. Soc. Nat. Hist. ii, p. 142 (1846); U. S. Expl. Exped. Moll., p. 312, f. 437, 437*a*; Otia Conch., p. 3.—*C.* (*Onithochiton*) *quercinus* GLD., Otia, p. 242.

Closely allied to *O. lyelli* and *O. rugulosus*.

O. RUGULOSUS Angas. Pl. 55, fig. 19.

Shell elongately ovate, a little narrowed in front, raised and carinated, pale yellowish-brown, the central areas of the valves faintly spotted with olive, the outer edges bordered with green, upon which and extending inward are concentric waved bands of olive brown darker at the margin; lateral areas not raised, divided from the dorsal areas by radiating nodulous ribs, transversely rugosely, costate; dorsal areas finely longitudinally ridged; mantle brown, variegated with ash-color and clothed with very minute chaff-like scales. (*Ang.*) Length 16 mill.

Port Jackson, Australia.

Onithochiton rugulosus ANG., P. Z. S. 1867, p. 115, 223, t. 13, f. 29.

Carpenter gives the following notes upon the type specimen: Shell broad, the valves much beaked, dorsal ridge acute. Mucro terminal. Jugal area scarcely distinct, smoothish; central areas having about 16 nearly longitudinal, jagged wrinkles, nearly meeting over the jugum. Lateral areas very sharply rugose, much more so than in the other species, the rugæ about 12, not developed in young shells, very irregular, swelling into granules especially on the diagonal lines and sutures. Anterior valve having 8 lines of black dots, with two additional, indistinct ones. Inside whitish with a brown spot in the cavity; posterior valve having the mucro absolutely terminal, the insertion-plate planed off. Anterior valve having 8 slits; teeth very finely rugose; sinus deep, flat, tolerably broad, with about 20 fine teeth. Girdle covered with minute hairs. Length 16½, breadth 12 mill.; divergence 125°.

O. AMICORUM Baird. Pl. 54, fig. 46.

Shell rather elongated, elevated, with acute dorsal ridge. There is a line of reddish-brown color along the dorsal ridge, and one or two others along the sides.

Lateral areas much elevated, with very nodulous wrinkles, two or three irregularly concentric; these are partly on the diagonal and sutural ribs, with others intercalated. Central areas with about 22 slightly irregular riblets, nearly longitudinal, but bending toward the

middle, the interstices very narrow. Anterior valve having about 20 radii, much smaller than those of the lateral areas, but toward the sutures becoming coarser than those of the lateral areas. Posterior valve depressed, the mucro subterminal.

Interior: anterior valve having about 9 slight slits, not corresponding to the outside dots. Central valves with 1 slit; teeth striated outside and at the broad, but sharp edge. Eaves planed off, scarcely grooved. Sinus broad, deep, with about 14 denticles.

Girdle stout, with shelly spines, exactly like magellanicus, principally whitish, irregularly tessellated with dark. (*Cpr.*, from type.) Length 18, breadth 10½, divergence 90.°

Niue or Savage Island, Friendly Group (Brenchley.)

Chiton (*Onithochiton*) *amicorum* BAIRD, in Brenchley's Jottings during the Cruise of H. M. S. 'Curaçoa' among the South Sea Islands, in 1865. London, 1873, p. 445, t. 40, f. 7.

The generic position of this species is uncertain, but could be readily ascertained by an examination of the type, which is, we believe, in the British Museum. It is probably either an *Onithochiton*, a *Liolophura* or a *Plaxiphora*. Baird's original description is as follows: "Shell ovate, nearly equal at each extremity; mantle margin covered with numerous chaffy-looking scales, first valve larger than any of the others, marked with numerous granular lines; central valves strongly striated, lateral areas with 2 or 3 granular lines; last valve small and striated. A line of a red color runs along the top of all the valves, whilst one or two others run along the lateral areas. Length 8 lines, breadth 5½ lines."

O. MAILLARDI Deshayes. Pl. 55, fig. 20.

Shell oblong, elevated, the dorsal ridge roundly angled, side-slopes nearly straight. Surface shining; color pale buff, with a narrow orange-tinted or brown triangle at the ridge of each valve, several dark-green spots along each diagonal slope, the lateral areas and head valve with concentric green-olive sometimes dark brown lines.

Median valve beaked, the lateral areas somewhat raised, having near the front margin a narrow radiating band of eye-dots, the width of the band greater on the hinder valves; sculptured with longitudinal grooves corresponding with the dark color-lines, sometimes irregular or branching; and continuing upon the diagonal slope. Upon the central areas these grooves become much more delicate,

closer, converging toward the dorsal ridge, and often zigzagged; the median triangle of the central areas smooth. Anterior valve having 8 narrow rays of eyes, occasionally with some eyes scattered between along the lower margin; the intervals between the eye-rays sculptured with sulci forming short arcs of concentric grooves. Posterior valve depressed, triangular; *its length from sinus to the posterior terminal mucro being one-half the greatest breadth* of its tegmentum.

Interior white, with a large spot of rich brown in each valve. Sinus delicately toothed, wide and deep. Anterior valve having 8 slits, median valves 1 slit; teeth finely and sharply pectinated outside. Posterior valve having a smooth ledge of callus in plate of the insertion-plate, flat behind, rounded at the sides. Eaves narrow, grooved, solid.

Girdle fleshy-brown, leathery.

Length 24, breadth 15 mill.; divergence 110°–115°.

Mauritus and Bourbon (Réunion.)

Chiton maillardi DESH., Moll. de l'Ile Réunion, p. 38, t. 5, f. 14. —*Chiton* (*Tonicia?*) *maillardi* MARTENS, in Möbius' Reise nach Mauritius, p. 300.—*Ornithochiton maillardi* CPR., *MS.*—*Ornithochiton sp.*, MOSELEY Quarterl. Journ. R. Mic. Soc. xxv, p. 54, t. 5, f. 4–7.

O. LITERATUS Krauss. Pl. 55, figs. 21, 22, 23.

Shell ovate, convex; brown, spotted with whitish and having a whitish longitudinal band; closely sulcate. Interior white, brownish-violet in the middle. Anterior valve lunate, convex with undulating grooves; posterior valve triangular, depressed, sculptured with angular grooves; intermediate valves sinuated in front, rounded at the sides, undulately and angularly grooved. Girdle rufous-brown, leathery, velvety.

Length 12, breadth 8 lines. (*Krauss.*)

Natal.

Chiton literatus KRAUSS, Die Südafrik. Moll. p. 36, t. 3, f. 6.

I have not seen this species, which is evidently quite distinct, although allied to *O. maillardi*. The central areas have angular or zigzag grooves; the lateral areas are not raised, and are sculptured with wavy grooves. The back is not carinated. Insertion plates as usual in the genus.

Genus XX. ENOPLOCHITON Gray, 1847.

Enoplochiton Gray, P. Z. S. 1847, pp. 65, 69, 169.

Valves exposed, of a uniform dark brown or chocolate color outside and within; the lateral areas and head valve irregularly studded with extremely minute eyes. Interior minutely laminated and punctate in a peculiar pattern; sinus deep, denticulate. Insertion-plates of anterior and median valves slit into teeth and sharply pectinated outside. Tail-valve having the mucro posterior and terminal, and inside with a flat ledge of callus in place of the lacking insertion-plate. Girdle fleshy, bearing extremely broad and short, blunt, separated striated scales.

The single species comprised in *Enoplochiton* resembles the larger *Onithochitons* in being polished and sculptured with wavy impressed lines (when not eroded) and also in the denticulate sinus, as well as in the structure of all the insertion-plates. It differs from *Onithochiton* in the peculiar texture and color of the valves, the sculpture of the interior and the structure of the girdle.

The eyes in this genus are extremely minute and oval instead of round. The megalopores and micropores are arranged in vertical lines (pl. 52, figs. 27, 28). The valves resemble those of *Mesotomura* in most respects, excepting the tail valve, which is that of *Onithochiton*.

E. niger Barnes. Pl. 52, figs. 22–29.

Shell oblong, convex, the valves thick and dark brown outside and within. Surface shining when perfect, but generally eroded and dull.

The valves are strongly beaked, and generally much eroded; but when not too much worn the sculpture is as follows: lateral areas marked with undulating longitudinal impressed lines; central areas having a series of short impressions in front of each diagonal rib, and an impressed V on the ridge of each valve; anterior valve having concentric wavy grooves; posterior valve much depressed, with posterior terminal mucro; sculptured like the median valves.

Interior seen under a lens to be sharply, densely laminate in front of the valve callus, punctate on the sutural plates and behind the valve-callus (fig. 25). Sutural and insertion plates of median valves thick, tending forward; sinus broad, rounded or angular, denticulate; anterior valve having 9 slits, median valves 1 slit; teeth long, deeply, sharply and closely pectinated outside. Posterior

valve having the mucro projecting beyond the narrow eaves; insertion plate obsolete, reduced to a callous ridge, flattened behind, rounded at the sides, and pectinated outside where it joins the sutural plates.

Girdle fleshy, bearing numerous wide, short, blunt, striated, separated scales (fig. 29, a young specimen); the interstices between the scales covered with a velvety pile.

Length 75–80, breadth 35–40 mill.

Peru (Capt. Ridgeley); *Coquimbo Bay* (Frembly); *Valparaiso* (U. S. Expl. Exped.)

Chiton niger BARNES, Amer. Journ. of Science and Arts, vii, p. 71, t. 3, f. 3 (1824).—*Enoplochiton niger* GRAY, P. Z. S. 1847, p. 69. —*Chiton coquimbensis* FREMB., Zool. Journ. iii, p. 197, t. 16, f. 2 (1827).—SOWERBY, Voy. 'Blossom' Zool., p. 149, t. 40, f. 6.—REEVE, Conch. Icon., f. 22.

The entire substance of the valves is colored in this remarkable species. Specimens as well preserved as the individual figured are not common; but so peculiar is the entire shell that it may readily be recognized, however eroded.

This species like *Acanthopleura spinifera*, lives upon the rocks between tides in situations exposed to the full force of the surf. In fig. 27 a portion of the surface of a valve is drawn magnified, showtwo eyes, megalæsthetes and micræsthetes; fig. 28 represents a portion more highly magnified, showing two megalæsthetes and the accompanying micræsthetes.

Family ISCHNOCHITONIDÆ.

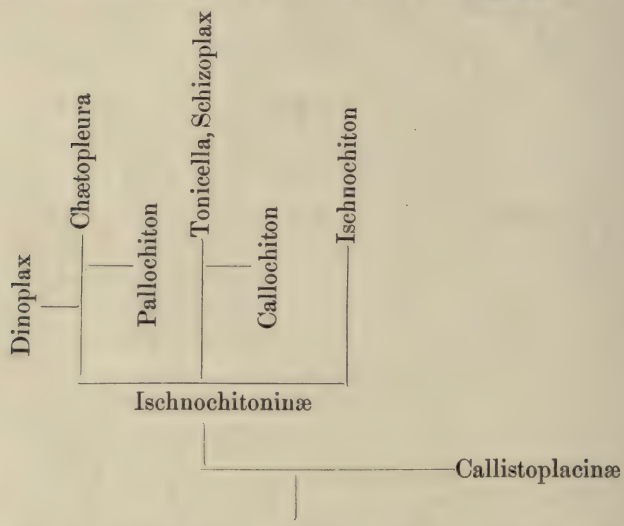
A number of genera belonging to the *Ischnochitonidæ* were omitted by me in my treatment of it in parts 1 and 2 of this volume, in deference to the views of Carpenter, who grouped them with *Acanthopleura* and its allies. A more profound study of this and related families, enables me now to see traits of relationship unknown at the time the synopsis on pages 23, 24, 25 was prepared, and therefore to group the genera more naturally than was then possible.

Subfamilies of Ischnochitonidæ.

CALLISTOPLACINÆ, in which the slits of the anterior and intermediate valves correspond in position to radiating ribs on the exterior. (See p. 259.)

ISCHNOCHITONINÆ, in which there is apparently no such relation between slits and external ribs.

This last subfamily includes the majority of species, and a considerable number of genera; and while there are still some obscure points, the light cast by what we already know of their morphology is sufficient to show us the approximate paths of generic descent, the genera falling into three main groups, as shown in the diagram.



It will be noticed that *Leptoplax* and *Spongiochiton* are not included. These genera belong to the *Acanthochitidæ*. Moreover, it must be remembered that *Trachyradsia* is a synonym of *Stereochiton* (see p. 52) and part of *Trachydermon* belongs to the Tonicelloid branch. These groups were erroneously placed in the text.

The following genera belong to the *Chætopleuroid branch* of Ischnochitoninæ and should have been inserted after the genus *Chætopleura* (p. 27.)

Genus XXI. DINOPLAX Carpenter, 1882.

Dinoplax CPR. *MS.*, in DALL, Proc. U. S. Nat. Mus. 1881, p. 284, 287 (Jan. 20, 1882).—*Acanthopleura* (in part) GRAY.—*Chætopleura* (part) SHUTTLEWORTH.—*Chiton s. s.* (in part) ADAMS, Gen. Rec. Moll. i, p. 474, 475, not of Linn.

Valves heavy, exposed, the lateral areas high; teeth of insertion sharp, smooth, those of the posterior valve directed forward; slits of

anterior valve not corresponding to external ribs. *Posterior valve having the mucro, posterior. Sutural plates broadly united across the sinus.* Girdle thick, leathery, with *minute bunches of delicate spinelets* scattered upon it.

The position assigned by Shuttleworth to the type of this genus was not far from correct. The Ischnoid insertion-plates, solid eaves and the leathery spiculose girdle are characters strongly binding *C. gigas* to *Chætopleura*. Upon parting the valves, however, we notice that the mucro in *C. gigas* is situated toward the rear, and the posterior teeth are thereby thrown forward, as in *Pallochiton;* the sutural plates are united by a brown "keystone" filling the sinus somewhat as in *Eudoxochiton* (p. 192); and the spicules of the girdle are gathered into little bunches different from any other Chiton. The valves, too, are remarkably solid. This combination of characters seems sufficient for the establishment of the genus *Dinoplax*, the position of which I take to be near *Pallochiton*.

D. GIGAS Gmelin. Pl. 57, figs. 21–32.

Shell oval, large, ponderous and strong, elevated, obtusely angled. Surface lusterless, eroded, ash-white in color with some brown smears, when adult; the young being prettily streaked or mottled with chestnut and bluish on a light ground.

Median valves not beaked; *lateral areas very much elevated*, radially striated in young shells and upon the outer edges of adults; central areas closely and finely foveolate in the young, and on the protected front edge of adult valves. Anterior valve elevated, its surface similar to the lateral areas. Posterior valve depressed but roof-shaped, *the mucro posterior*, the slope behind it nearly vertical.

Interior whitish, flesh-colored on the sutural plates and marked with brown at their bases; having two broad chestnut rays behind. Sutural plates wide, *connected across the sinus* by a broad key-stone shaped lamina. Anterior valve having 8–10, central valves 1, posterior valve 8–10 slits; teeth acute, smooth, those of the posterior valve rather stumpy, wedge-shaped, directed forward. Eaves solid.

Girdle fleshy, strong, blackish, beset with numerous tiny bunches of minute spinelets (fig. 31.)

Length 70, breadth 45 mill.

Length 100, breadth 56 mill.

South Africa, at Table Bay, Natal, Port Elizabeth and Algoa Bay.

Chiton maximus a Promontorio Bonæ Spei CHEMNITZ, Von einem Geschlechte vielschalichter Conchylien mit sichtbaren Gelenken,

fig. 10 (1784).—*Chiton maximus seu gigas* CHEMNITZ, Conchyl. Cab. viii, p. 292, t. 96, f. 819 (good), 1785.—*Chiton gigas* GMEL., Syst. Nat. xiii, p. 3206 (1788).—SPENGLER, Skrivter af Naturhistorie-Selskabet, iv, p. 101 (1795).—WOOD, Gen. Conchol., p. 12 (1814).—BRUG., Encyclop. Meth., t. 161, f. 3 (copied from Chemnitz).—LAMARCK, An. s. Vert. vii, p. 490.—BLAINVILLE, Dict. Sc. Nat. xxxvi, p. 543.—REEVE, Conch. Icon., f. 65.—KRAUSS, Die Südafrik. Moll., p. 40, t. 3, f. 3 (young).—H. & A. ADAMS, Genera Rec. Moll. p. 475.—SOWB., Marine Sh. of South Africa, p. 50.—*Chætopleura gigas* SHUTTLEW., Bern. Mittheil. 1853, p. 67.—*Acanthopleura gigas* GRAY, P. Z. S. 1847, pp. 68, 169.—*Chiton subgigas* BLAINVILLE, Dict. Sc. Nat. p. 543 (young specimen).—*Dinoplax gigas* CPR., *MS.*—*Chiton albus* BARBUT, The Genera Vermium of Linnæus, Pt. 2d. (London, Mar. 2, 1788), Vermes Testacea, p. 8, t. 1, f. 1 (not *Ch. albus* Linn.)

The dull, corroded aspect of this large species seems to be invariable in adults. The strongly raised lateral areas, black, leathery girdle, and peculiar contour render it very distinct in appearance. The figures of Chemnitz are most characteristic, but that it is impossible to quote him as authority for the name must be admitted. Although the bibliography of this species is rather extensive, the only references worth reading are Chemnitz, Krauss and Carpenter.

Rochebrune has cited this species from the strait of Santiago, Cape Verde Archipelago (Nouv. Arch. du Mus. iv, p. 239, 1881), but his paper contains such a host of erroneous locality citations that one hesitates to accept any of them without confirmation.

Genus XXII. PALLOCHITON Dall, 1882.

Hemphillia CARPENTER *MSS.*, type *H. lanuginosa* Cpr. *MSS.* Not *Hemphillia* Bland & Binney.—*Pallochiton* DALL, Proc. U. S. Nat. Mus. 1878, p. 297 (dentition described, but no generic diagnosis, and founded on the undescribed species *P. lanuginosus*. Feb. 13, 1879).—*Pallochiton* DALL, Proc. U. S. Nat. Mus. 1881, p. 283, 287 (Jan. 20, 1882).—? *Arthuria* CPR.

Valves exposed, solid, the anterior and median having sharp insertion teeth slightly roughened outside; slits of anterior valve not corresponding to anything in the external sculpture; tail valve having the mucro at the posterior end, the teeth sharp and all strongly directed forward; eaves solid; sinus notched at sides. Girdle leathery, with a few deciduous hairs, but no pores.

This genus closely resembles in sculpture as well as structural characters, *Chætopleura* Shuttlew.; differing only in the posterior position of the mucro and the consequent throwing forward of the tail-valve insertion-teeth,—characters of no great importance. The slits correspond in position to nothing in the external sculpture. The girdle is decidedly like *Chætopleura*, being very sparsely hairy (or smooth) and lacking all appearance of pores.

P. LANUGINOSUS Carpenter, n. sp. Pl. 56, figs. 1–11.

Shell oblong or ovate, rather elevated, carinated, the side-slopes nearly straight. Surface lusterless, color very variable; sometimes dull brown or purplish-brown; sometimes green along the ridge and purple or lilac dotted with black or olive at the sides; or having the sides of some valves scarlet or even snow-white.

The median valves are rather acutely beaked in the young, beaks eroded in old specimens. Lateral areas but little raised, sculptured with gem-like pustules scattered irregularly on a flat (microscopically puncticulate) ground; the pustules often few, rarely wanting on some valves; central areas sculptured with *many closely beaded longitudinal threads*, which converge slightly at the ridge, and diverge toward the outer sides of the valves; on the second valve they diverge at the ridge. Head valve pustulose like the lateral areas. *Tail valve* (fig. 11) *much depressed, the mucro at the posterior end;* anterior area wide, sculptured like the central areas; *posterior area very narrow, vertical*, sometimes pustulose.

Interior bluish-white, darker at jugum and posteriorly; rarely flesh or pink tinted. Sutural plates very broad; sinus narrow, deep, angular and notched at the sides. Anterior valve having 8–9, central 1 slit, the teeth long, sharp, a little rugose outside; posterior valve having 10–11 slits, *the teeth chisel-shaped, strongly directed forward*, smooth and rather sharp. Eaves of anterior and median valves narrow, of posterior valve wider, solid.

Girdle rather fleshy, leathery when dried, somewhat encroaching at the sutures, and smooth or clothed with sparse delicate hairlets.

San Diego, California; Todos Santos Bay to Pta. Abreojos, Lower Cal.

Hemphillia lanuginosa CPR., *MS.*—*Pallochiton lanuginosus* Cpr., DALL, Proc. U. S. Nat. Mus. 1878, p. 297, pl. 3, fig. 21 (dentition). —*Chiton* (*Pallochiton*) *lanuginosa* (Cpr.) Dall, ORCUTT, Proc. U. S. Nat. Mus. 1885, p. 544.

?? *Chiton puncticulatus* REEVE, Conch. Icon., *Chiton*, no. 69 (in part.)

The posterior terminal mucro, leathery girdle, and beaded sculpture well distinguish this species. The coloring of some specimens (such as those from S. Ignacio Lagoon, Lower California, represented by fig. 1, 6) is of exquisite delicacy. Old individuals generally lose the pustules of the surface except at the base of the valves. One of Reeve's illustrations (fig. 69*a*) is said to represent a specimen of this species; but as the other (fig. 69*b*) is certainly an *Onithochiton*, and as the description indicates that rather than the *Pallochiton*, I have preferred to retain Carpenter's name for this species.

A peculiarity of coloring not mentioned in the description is the vertical white stripe extending down the posterior slope from the mucro of the tail valve. In the great number of individuals examined by me I have never found this lacking.

Section ARTHURIA Carpenter, 1882.

Arthuria CPR. *MS.*, in DALL, Proc. U. S. Nat. Mus. 1881, pp. 284, 287 (Jan. 20, 1882). Type *A. filosa* Cpr.

Shell thin; valves waved; mucro posterior, produced. Insertion plates acute, smooth, projecting forward in the posterior valve; sinus flat, laminate, smooth. Girdle leathery, smooth or downy. (*Cpr., MS.*)

This section seems to present no characters separating it from *Pallochiton*. I have not seen the type and only species, and it has not been figured. Comparisons should be made with *Pallochiton lanuginosus* Cpr.

P. FILOSUS Carpenter, n. sp.

Shell oval, subelevated, the *dorsal ridge acute; mucro posterior*, hardly terminal, *elevated on a strong marginal ridge, the outline in front of it concave.* Intense or pale olivaceous.

Valves delicate, rounded at the margin, making deep sutures. *Central areas having about* 13 *distant, beaded subparallel threads on each side*, sometimes obsolete, and closer and subacute upon the ridge. Lateral areas moderately defined, and together with the end valves having *irregularly scattered rounded granules.*

Interior: anterior valve having 10, central 1, posterior valve 9–10 slits; teeth of the posterior valve solid, acute at the edge, *strongly inclined forward*, the slits sloping; the other valves having very

acute teeth. Eaves of posterior valve wide, flat, subspongy; of other valves moderate, hardly grooved. Sinus narrow, deep, hardly toothed, slit at the sides, at the junction of the sutural plates.

Girdle leathery, smooth or most minutely and closely downy.

Length 29, breadth 16½ mill.; divergence 110°–120°.

Habitat unknown.

Arthuria filosa Cpr. *MS.* and in Dall, Proc. U. S. Nat. Mus. 1881, p. 287 (name only). Types in Mus. Cuming, nos. 23, 38.

Carpenter's description is given above. He remarks:

"This shell has the tail plate of *Nuttallina*, but the other valves more resemble *Chætopleura* or *Tonicella*. It is known externally from *Nuttallina* by the nearly smooth girdle; but would hardly be distinguished from *Ornithochiton* except by the regular articulation of the insertion-plates. In the Ischnoid genera, the posterior profile from the mucro is often concave; in this the anterior. In consequence of the great projection of the beak, both in *Nuttallina* and *Arthuria*, the posterior teeth appear plumulate rather than fissured; a character also seen in *Callistochiton*. The terminal valve in both the specimens examined are exactly alike in color as well as markings; but the central valves in one specimen are of a much lighter color, with more delicate and well developed sculpture."

Subfamily Callistoplacinæ.

Ischnochitonidæ in which the slits of the anterior valve correspond in number and position to the radial ribs of the exterior. Teeth generally thickened at the edges of the slits.

In this subfamily, which seems to be a natural division, may be placed a number of genera widely scattered in Carpenter's scheme. These genera fall into three groups, or branches, lettered *a*, *aa*, and *aaa* in the following table. The first of them seems to have affinities with the typical Ischnochitons, the second slightly resembles the *Acanthochitidæ*, and the third may be somewhat allied to the *Mopaliidæ*.

The number of anterior slits sometimes exceeds the number of external ribs, so that the subfamily diagnosis must not be taken too literally. The *plan of structure* is sufficiently obvious; but exuberant Nature knows nothing of absolute adherence to rules.

Key to genera of Callistoplacinæ.

a. Surface of valves having strong radial ribs; girdle densely clothed with imbricating scales, CALLISTOCHITON.

aa. Surface of valves granulated or pebbly; girdle not densely imbricated with scales.

b. Anterior valve with more than 7 slits; sinus very spongy; mucro posterior, NUTTALLINA.

bb. Anterior valve with 5 slits; mucro subcentral, not posterior, CRASPEDOCHITON, ANGASIA.

aaa. Surface of valves wrinkled or ribbed; girdle naked except for hairs or corneous spines.

b. Valves having very strong radial ribs; girdle naked, with sutural tufts, CALLISTOPLAX.

bb. Valves not very strongly sculptured; girdle tough, with corneous curved spine-like processes, CERATOZONA.

Genus XXIII. CALLISTOCHITON Carpenter, 1882.

Callistochiton CPR., Table of Regular Chitons, 1873.—DALL, Proc. U. S. Nat. Mus. 1881, p. 283, 289, 290 (Jan.-Feb., 1882).—*Callochiton* (in part) H. & A. Adams, and of CARPENTER, P. Z. S. 1865, p. 276, not of Gray.

Valves conspicuously sculptured; the insertion-plates short, smooth or nearly so, festooned, being curved outward at the ribs and slit there, thickened outside at the edges of the slits, the latter corresponding in position to the ribs of the outer surface. Sinus squared. Mucro median or post median, generally depressed. Girdle poreless, densely clothed with minute striated or smooth scales. Type, *Chiton pulchellus* Gray.

This genus differs from *Ischnochiton* in the peculiar insertion-teeth, which are curved into the ribs as if festooned, in the relation of the slits to the external ribs, and in the tail valve, which is often peculiarly humped.

The species though not numerous, are widely distributed, Australia, Red Sea, Japan and the Gulf of Mexico together furnishing about half, the rest being from the western coast of the Americas, from southern California to northern Chili.

Nearly all of the species have the lateral areas strongly bicostate and granose; the end valves have strong ribs, the number of which

is less valuable as a specific character than one would at first suppose, on account of their tendency to increase by splitting. When a rib splits, an additional slit appears in the insertion-plate; so that this character also is largely vitiated.

The best characters for distinguishing species are the sculpture of the median portion of the central areas, and the contour of the tail valve; the *profile* of the latter being especially characteristic and constant.

The following notes from Carpenter's MS. apply more especially to the more typical forms: "It is quite possible that in their earlier stages these curious shells resemble *Ischnochiton;* but as they proceed toward maturity, while they spread naturally in the seven anterior valves, the posterior is simply raised a tier higher; consequently, in the adult, the posterior part of the tail plate resembles a closed fist outside; and within the teeth and eaves are very broad and blunt. There is an approach toward the throwing forward observed in *Acanthopleura.* In *Ischnochiton,* whatever be the external sculpture, the row of teeth follow the same oval line, and the incisions do not correspond (except by accident) with the external ribs; whereas in Callistochiton the tooth line is elegantly scalloped in and out of the hollows of the ribs.

"In general the incisions are in the centre of each rib, and the plates are there propped outside, as in *Callochiton;* but sometimes a separate keystone (as it were) is let into some or all of the arches on the terminal valves. The genus appears to culminate on the California coast, and reaches its greatest development in *C. palmulatus;* in which the posterior valve displays the further peculiarity of each tooth being broken up into a number of fingers, each fluted, and so arranged that the inner margins form a semicircle while the outer present the scalloped curve of the genus. The valves are peculiarly solid and are easily detached from the thin and narrow zone. The sinus has always a lamina, which is generally marked off by slits from the sutural laminæ, but is scarcely ever dentate. Two of the species have minute, smooth scales."

Key to species of Callistochiton.

One species, *C. heterodon* Pils., has pectinated teeth like a typical *Chiton,* and it is placed in this genus with much doubt; the others may be tabulated thus:

a. Central areas having a pitted or net-like pattern toward the beaks.

b. Mucro posterior, not depressed, tail valve with 7 ribs; scales smooth, *pulchellus.*

bb. Mucro subcentral, the slope behind it concave, scales striated, *shuttleworthianus.*

bbb. Mucro subcentral, tail valve rapidly sloping backward from the front margin; eaves narrow; scales striated, *antiquus.*

aa. Central areas smooth in the middle, *decoratus.*

aaa. Central areas sculptured throughout with parallel liræ.

b. Posterior area of tail valve swollen above the anterior area, *palmulatus.*

bb. Posterior area not higher.

c. Mucro posterior; riblets converging on ridge, *crassicostatus.*

cc. Mucro subcentral, riblets not converging on ridge.

d. Profile of tail valve convex, mucro obtuse, *infortunatus.*

dd. Profile of tail valve rapidly sloping backward from the front margin, mucro flat, *gabbi.*

The species *elenensis* and *expressus* from western Middle America, and *adenensis* from the Red Sea, probably belong in the last section of the above table, but I have seen no specimens. *C. jacobæus* of Gould also belongs near *infortunatus*, probably.

C. PALMULATUS Carpenter, n. sp. Pl. 58, figs. 7–16.

Shell similar to *C. pulchellus*, but more flattened, the dorsal ridge acute; mucro subcentral, depressed, the posterior area strongly swollen; sculpture stronger; central areas having about 10 subparallel acute liræ on each side, pectinating the sutures, interstices deeply cancellated; lateral areas having two strong ribs bearing strong tubercles, the sutures dentate, interstices deeply punctate. Anterior valve having 11 ribs, of which the outer two are joined; posterior valve 7 very strong ribs bifurcating behind.

Interior: anterior valve having 11 slits, central 1 slit, the teeth normal; posterior valve having 26 slits, the teeth crowded, minute, palmate. Eaves very strong; sinus small, strongly laminate, the

lamina deeply slit on each side. Girdle imbricated with striated scales.

Length 11¼, breadth 7½ mill.; divergence 135°. (*Cpr.*)

Sta. Barbara (Cooper, Cal. State Coll. no. 1077); *Monterey* (Canfield, coll. Cpr.)

The above description is quoted from Carpenter's MS. He gives the following additional notes: "This species with a general resemblance to *pulchellus*, is known outside by its stronger sculpture, flattend anterior and tumid posterior valve; and by its sharp back with flattened sides. It is one of the most remarkable peculiarities of Chitons that they are so particular in special adornment of their tails, while their heads are covered with very uniform plates. In this species this peculiarity culminates. Not only the radiating and furbelowed arrangement of the teeth presents the greatest differentiation yet observed in a Chiton, but the fluting of each individual finger-like tooth adds special beauty to the complex pattern."

Figures 7, 8, 13–16 are from drawings prepared for Dr. Carpenter; fig. 12 represents the tail valve of a typical specimen before me, for comparison with that of the following variety.

Var. MIRABILIS Pilsbry, n. v. Pl. 58, figs. 7, 8, 9, 10, 11.

Shell oblong, elevated, the back angular, side-slopes convex. Surface lusterless, dull brownish, the lateral areas and end valves blackish.

Valves not beaked; the lateral areas widely separated by the eroded beaks, *greatly elevated, each split by a deep median sulcus,* the two ribs thus formed bearing coarse transverse grains. Central areas sculptured with about 15 narrow longitudinal cords, *parallel at the dorsal ridge except on the second valve in which they diverge forward;* the interstices wider than the cords, and finely latticed across. *Anterior valve having* 9 *stout radiating ribs,* strongly granose, and with the exception of the two outer ones, they are generally not bifid. *Posterior valve much higher than the anterior,* the mucro somewhat in front of the middle, *the area behind it enormously developed, elevated and convex,* sculptured with 4, 5 or 6 primary stout ribs, each of which splits into two; the two outer ribs are broader, and split into several riblets.

Interior bluish-white; sutural-laminæ slightly connected across the squarish sinus. Anterior valve having 9, central 1, posterior valve 22 slits; teeth short, somewhat roughened. Eaves broad, calloused.

Girdle narrow, thin, covered with very densely imbricating minute deeply striated scales (fig. 8.)

Length 16, breadth 7 mill.

San Diego, California.

The form described above was known to Dr. Carpenter by one perfect though worn specimen and a single worn posterior valve. He gives (*MSS.*, p. 134) the following notice of it, under *C. palmulatus.*

"? *Variat.: ar. centr. liris utr. lat.* 16–18; *v. post.* 5, *bifurcatis; mucro usque ad dimidium totius altitudinis depresso; sinus lamina vix fissata. Long.* 15, *lat.* 7½, *diverg.* 110°."

These lines give the essential points of difference between this variety and the typical form, *viz.*, the more numerous side riblets of the central areas in a shell of the same width, the greatly elevated posterior area of the tail valve, the greater proportionate length and altitude of the shell and the smaller angle of divergence. The value of these characters for distinguishing the two forms remains to be seen, and can only be ascertained by the examination of abundant material. That this form is not merely a fully grown (ephebic) or old (gerontic) state of the original *palmulatus* is shown by the comparison of small specimens, not exceeding in length the typical *palmulatus* before me.

The enormously swollen posterior area of the tail valve separates this from all other species. In several additional details the form differs from *C. crassicostatus*, notably in the strongly two-ribbed lateral areas, the more numerous ribs of the anterior valve, the riblets of the central areas being parallel at the ridge except on the second valve where they diverge; whilst in *C. crassicostatus* they converge forwardly on all of the median valves. The seventh valve of this form is distinctly narrower than the other valves, being crowded by the unusually developed tail-valve.

The type specimen is in the collection of the Academy.

C. CRASSICOSTATUS Pilsbry, n. sp. Pl. 58, figs. 1, 2, 3, 4, 5, 6.

Shell oblong, elevated, the dorsal ridge very obsoletely angular, side-slopes arched. Surface lusterless, green or brown.

Valves not beaked, the *lateral areas extremely prominent, unevenly granulated*, the concentric riblets being cut by one or several radiating grooves. Central areas having strong longitudinal bars, *converging Λ-like on the ridge* (*even on the second valve*), the intervals

very closely and finely latticed across. *Anterior valve having seven very strong ribs*, each divided by a shallow median groove. Posterior valve elevated, having *the mucro directly over the posterior edge, he hinder area not higher than the area in front of it;* posterior slope vertical, convex, sculptured with five very strong, deeply separated ribs, which are granose above, and subdivide into several riblets each toward the lower margin.

Interior bluish-white; sutural-plates slightly connected across the rounded sinus. Anterior valve having 9, central valves 1, posterior valve 13–20 slits; teeth short, rather sharp and smooth, hardly projecting below the eaves, thickened along the slits outside; eaves broad, solid.

Girdle narrow, thin, covered with excessively minute, closely imbricating, striated scales.

Length 22, breadth 9 mill.

Monterey, California.

Callistochiton fimbriatus CPR., *MSS.* 1875. Not *Callochiton fimbriatus* Cpr. in COOPER, Geographical Catalogue of the Mollusca found west of the Rocky Mountains, between Latitudes 33° and 49° North (Geol. Surv. of Cal.), p. 23, 1867 (no description),=*Callistochiton pulchellus*, Cpr. *MSS.* 1875.

? *Chiton* (*Callochiton*) *fimbriatus* Cpr., ORCUTT, Proc. U. S. Nat. Mus. 1885, p. 544 (1885), no description. Not *Chiton fimbriatus* SOWB.

This species is readily separated from the next by the smaller number of ribs on the head and tail valves, the less distinctly bicostate lateral areas, and the far less elevated tail valve, which has, besides, a posterior terminal mucro.

The specimens before me were collected by Henry Hemphill at Monterey. A species under this name has been reported from San Diego and from Catalina Island, but the identity of the specimens with the present species is open to doubt, although its occurrence in those places is not improbable.

The name of this species is involved in some obscurity, owing to the fact that no diagnosis or description whatever has heretofore been published, although the name *fimbriatus* has appeared in several lists. This much however is certain: that the original *fimbriatus* Cpr. of Cooper's Catalogue, the unique type of which is said to be in the Smithsonian Institution collection, is not the *fimbriatus* of Carpenter's later MSS. (*Vide* Carpenter's *MSS.* vol. I, p. 135); and we

have no means of knowing whether the *C. fimbriatus* of Orcutt's San Diego list was identified from Carpenter's earlier type specimen, or his later MSS. Everything considered, the best course open to us seems to be the selection of an entirely new name. The type is in the collection of the Academy.

C. INFORTUNATUS Pilsbry, n. sp. Pl. 59, figs. 37–42.

Shell large, regularly ovate, the dorsal ridge obtuse; valves arcuate; *mucro obtuse, median.* Olivaceous, sometimes spotted with paler on the ribs and jugum.

Central areas having about 12 parallel liræ on each side, decussated, the interstices having square depressions. Lateral areas having two very strong rounded tuberculose ribs. Anterior valve with 9, posterior with 7–8 elegantly spreading ribs.

Interior: posterior valve having 7–8, central 1, anterior 9 slits; teeth concave outwardly, obtuse, slit at the apices of the ribs, sometimes with an intercalated slit or abnormally serrate; teeth of posterior valve very obtuse, hardly sloping; eaves small, delicate. Sinus wide, flat, but little angular, sometimes crenulated by the riblets of the exterior. Girdle irregularly imbricated with flattened scales, each one about 6-striated (fig. 39.)

Length 17½, breadth 8¾ mill.

Equador (Cuming); *La Paz, W. Mexico* (Pease.)

Callistochiton pulchellus CARPENTER, *MSS.* Not *C. pulchellus* Gray, *q. v.*

The sculpture of the central and lateral areas resembles that of *C. palmulatus*, but the tail-valve (figs. 38, 42) is entirely different in form. This shell was sent to Dr. Carpenter by Cuming as the true *C. pulchellus* of Gray, but it is certainly not that species. The above description and the figures are from Carpenter's MSS. and unpublished drawings of his type.

The shell recorded by Dr. J. G. Cooper from "Catalina (or other?) I., Cal." under the name *Callochiton fimbriatus* Cpr. *MSS.*, and by Carpenter (in *MSS.*) from "S. Pedro" (both referring to the same specimen) may be a variety of this species, but no definition of it has been published, the locality is uncertain, and Dr. Carpenter in his later *MSS.* shifted the name *fimbriatus* to another species, leaving the form under discussion as a nameless variety of his *C. pulchellus.* Under these circumstances it has been thought best to expunge the name *fimbriatus* from the list of valid species.

C. JACOBÆUS Gould. *Unfigured.*

Shell small, ashy, elongated, elliptical, hardly carinated; end valves very large, vaulted, ornamented with 10 scaly radiating ribs; central areas cancellated; lateral areas conspicuous, bicostate. Ligament narrow, covered with minute elongated scales.

Length 12, breadth 5 mill. (*Gld.*)

Interior: posterior valve having 7, anterior 10, central 1 slit; teeth acute, curved outwardly; eaves solid; sinus wide, nearly flat, laminate, the lamina more or less separated from the sutural plates [by notches at the sides of the sinus]. Girdle imbricated with flat, striated scales. (*Cpr.*)

Simoda, Japan (North Pacific Expl. Exped.)

C. (*Leptochiton*) *Jacobæus* GLD., Proc. Boston Soc. Nat. Hist. vii, p. 164 (Dec., 1859); Otia Conch., p. 117.—*Callistochiton jacobæus* CPR., *MSS.*

Carpenter gives the following notes; but it must be remembered that his *C. pulchellus* is not the true *pulchellus* of Gray.

"If this shell had come from Central America, I should certainly have regarded it as *C. pulchellus* with which it exactly agrees in sculpture, number of ribs, size and striation of the scales, and general aspect. Indeed it can scarcely be separated as a variety, like the Californian shell. Inside, however the teeth are somewhat sharper, one of them having an extra slit. The lamina which lines the sinus is very thin and sharp, generally (but not always) marked off from the sutural plates by slight slits. In some valves, the lines which mark it off are perceptible, but they do not serrate the edges. It is also much broader in some valves than others. Whether the species are or are not identical, cannot be decided from the single specimen in the Smithsonian Museum. It is very singular that a shell from equatorial S. America should be replaced by a very distinct species in the Bay of Panama, should reappear in the Gulf of California, be still found in the temperate seas of California and lastly display a representation on the shores of Japan." (*Cpr.*)

C. ELENENSIS Sowerby. Pl. 59, figs. 27, 28.

Shell oblong, pallid; back rounded; anterior valve radiately sulcate; lateral areas of the intermediate valves swollen, unisulcate; posterior valve retuse, radially sulcate behind; central areas of the intermediate valves irregularly sulcate-scabrous; margin smooth.

Length ·6, breadth ·3 inch. (*Sowb.*)

St. Elena and Panama.

Chiton elenensis SOWERBY, P. Z. S. 1832, p. 27.—*C. ellinensis* SOWB., Conchol. Illustr., p. 6, f. 69.—*Ischnochiton elenensis* CPR., P. Z. S. 1865, p. 275.—Probably *Chiton janeirensis var.?* GRAY, Spicil. Zool., not of Sowerby and Reeve.

Sowerby's original description and figures given above. I have not seen this species, and place it in *Callistochiton* with some doubt, as its internal characters may demand for it a position in *Ischnochiton*. Haddon considers it very closely allied to *C. decoratus* Cpr. Carpenter has identified with this species a Panama form collected by Prof. C. B. Adams. He gives the following description of it:

"Outside having the central areas decussated with about 20 parallel bars; lateral areas having two strong, swollen, tuberculose ribs. Interior having the sutural [posterior] margin reflexed, tuberculate, with a small sinus; insertion plates 1-slit, sinus very broad. Front valve having 12 ribs, not very strong, and ten slits within, the teeth acute, eaves narrow. Posterior valve having the mucro subposterior, depressed; the slope behind it expanded, concave, with about 12 subobsolete ribs; inside with 9 slits, the teeth short, eaves small, callous within. The central valves of this species are normal; but the posterior valve offers a transition toward Callochiton [=Callistochiton], the outside being concave posteriorly, the insertion-teeth short, and the eaves callous. (*Cpr.* in P. Z. S.). The sinus is unusually broad and shallow, the sutural laminæ not being marked off. (*Cpr.*)

C. EXPRESSUS Carpenter. *Unfigured.*

Shell similar to *I. elenensis*, but flesh-colored. Central areas having 10 distant closely decussated bars; dorsal ridge acute, lateral areas having two very strong, narrow ribs with narrow tubercles; inside having the posterior margin flat, hardly tuberculose, hardly sinuated; sinus narrow, angulated at the jugum. Anterior valve having 10 strong, narrow ribs; interior as in *elenensis*, but with 8 slits. Posterior valve having a flat posterior mucro, the slope behind expanded, hardly concave, with about 7 very strong ribs; inside having about 7 slits, the eaves flat.

"With a strong general resemblance to *I. elenensis*, the differences in detail in the only two specimens examined, as above stated, appear of specific importance. If only varietal, it is equally important to notice how much change is tolerated by the habits of the animal. It may be the shell called *Chiton clathratus* by Professor

Adams, of which there were no duplicates to compare. It offers a still more marked transition to *Callochiton*, the margin of the posterior valve being somewhat pectinated by the great projection of the ribs. (*Cpr.*)

Panama (C. B. Ad.)

Ischnochiton (*? var.*) *expressus* CPR., P. Z. S. 1865, p. 275.

This species, like the last, is not known to me by specimens, the above description and notes being from Carpenter's paper in the P. Z. S. In his *MSS.* Carpenter places it in the *smooth scaled* section of *Ischnochiton*, and gives some additional notes, as follows: "This shell is almost exactly like the young of *I. serratus*, agreeing not only in the peculiar and beautiful sculpture, but even in the mantle scales. Yet it differs remarkably in the abnormal, narrow pointed sinus, in which respect it resembles *I. tectiformis*. One of these species is probably the *C. clathratus* of C. B. Ad. (Pan. shells, p. 242), and possibly of Reeve."

C. DECORATUS Carpenter, n. sp. Pl. 58, figs. 17–20.

Shell oblong, moderately convex, obtusely subangular along the dorsal ridge, the side-slopes slightly convex. *Surface rather shining*, varying in color from olive-buff to dark green, uniform or having darker flammules and spots.

Apices of the median valves eroded. Lateral areas raised, each rendered bicostate by a central sulcus, and having a few uneven longitudinal impressed grooves, giving it a *terraced* aspect. Central areas having numerous parallel longitudinal ribs, the intervals closely latticed across, this *sculpture obsolete on the ridge, where there is a broad* V*-shaped smooth area*, which rarely shows a few diverging subobsolete ribs. Anterior valve having 11 rounded ribs. Posterior valve less elevated than the anterior, *highest at the front margin, the mucro depressed, post-median;* posterior area having 9–10 rounded ribs.

Interior bluish, generally marked with olive or green at jugum, bases of the sutural-plates, and slit-rays. Sutural plates wide, separated by a square sinus notched at each side. Anterior valve having 9 or 11, central 1, posterior valve 9–12 slits; teeth rather sharp, smooth; slit-rays distinct and porous. Eaves narrow.

Girdle narrow, ashy-brown, covered with minute, striated, closely imbricating scales.

Length 20, breadth 9–10 mill.; divergence about 110°.

Todos Santos Bay and near San Tomas River, Lower California.

Callistochiton decoratus Cpr., *MSS.*—*Chiton* (*Callistochiton*) *decoratus* Cpr., Orcutt, Proc. U. S. Nat. Mus. viii, p. 544 (1885,) no description.

It has been reported from San Diego by Orcutt and from La Paz by Carpenter (Pease coll.)

The partially sculptured central areas are peculiar and characteristic, and the tail valve presents features not found in the other species of the same region. The figures 17–20 may be regarded as the types, but some individuals show some very obsolete coarse ribs in the front part of the jugal smooth tract.

The type is in the collection of the Academy.

C. gabbi Pilsbry, n. sp. Pl. 60, figs. 7–10.

Shell oblong, convex, rather sharply carinated, the side-slopes somewhat convex. Surface lusterless, the central areas light brown, lateral areas olivaceous-brown.

Median valves not beaked; lateral areas composed of two strongly elevated ribs, bearing acute grains, the posterior rib wider, having an additional row of smaller grains along the sutural margin; the sulcus between the ribs rather wide, minutely pitted. Central areas having about 15 parallel longitudinal riblets, becoming diverging toward the outer margins, the interstices very closely, sharply cross-latticed; region of the beaks smoother, pitted and microscopically granulate. Anterior valve having 9 strongly elevated ribs separated by pitted intervals of the same width as the ribs, the latter bearing acute grains; the posterior rib on each side wider, with sutural grains; region of the beak excavated. *Posterior valve elevated at the front edge, rapidly sloping backward, the mucro about central, much depressed;* posterior area sculptured with 7 rather broad wave-like radiating ribs surmounted by acute grains.

Interior light olivaceous, with dark markings under the beaks. Sutural plates well developed, separated by a narrow, angular, convex sinus. Anterior valve having 9, central 1, posterior valve 8 slits; teeth rather short, smooth, festooned and slit at the ribs. *Eaves, especially in the tail valve, extremely narrow.*

Girdle covered with very compactly imbricated, wide, finely striated scales, which are arranged in alternate patches of olive-bluish and lighter, the light patches being composed of mingled bluish, tawny and white scales (fig. 7.)

Length 14, breadth 8½ mill.; divergence about 110°.

Gulf of California (Gabb.)

In the depressed mucro and internal coloring, as well as the narrow eaves, this species resembles *C. decoratus* Cpr.; but the sculpture is much stronger, and is not obsolete at the dorsal ridge of each valve. The *C. elenensis* of Sowerby, a species which I have not seen, seems to be similar, but judging from Sowerby's figure the mucro of that species projects at the summit of the posterior slope, which is far from being the case with the form before me. The form described as *elenensis* by Carpenter differs in having a very wide sinus, weaker sculpture, etc. It should be compared with Carpenter's unfigured *Ischnochiton expressus*, a species not known to me autoptically.

The type is in the collection of the Academy.

C. PULCHELLUS Gray. Pl. 60, figs. 1–6.

Shell oblong, rather depressed, the dorsal ridge subangular, side-slopes convex. Of a soiled buff color, the girdle darker, ashen.

Valves not beaked; lateral areas raised, cut by a sulcus into two prominent ribs, of which the posterior is wider, sculptured with low, transversely elongated grains, serrating the sutures, the anterior rib having less conspicuous grains. *Central areas in the middle pitted in diagonal series*, the pattern becoming coarser on each side, then changing into longitudinal fine riblets on the outer half of each side. Anterior valve having 10 (or 12) strong rounded ribs, cut into low transverse grains by superficial concentric impressed lines. *Posterior valve abruptly depressed at the mucro, which is behind the middle, the forward area level, reticulated, the posterior area bearing 7 stout ribs;* the posterior ones are strongly bent.

Interior whitish; sutural-plates rounded, separated by a wide sinus, which is angular but hardly notched at the sides, and not perceptibly laminate. Slits in head-valve 10, median valves 1, posterior valve about 14; teeth thin but normal in front and median, irregular in the posterior valve. Eaves narrow.

Girdle narrow, *densely imbricated with minute smooth,* flattened scales.

Length 10, breadth 5 mill.; divergence 135°.

Arica, Chili (Hennah.)

Chiton pulchellus Gray, Spicilegia Zoologica, pt. 1, p. 6, t. 3, f. 9, (July 1, 1828).—Reeve, Conch. Icon., t. 23, f. 153 (? and perhaps t. 25, f. 168).—*Chiton* (*Callochiton*) *pulchellus* Morch, Mal. Blat. vii, p. 176.—*C. bicostatus* d'Orbigny, Voy. dans l'Amér., Merid., p. 486, t. 81, figs. 7–9.

? *Chiton pulchellus* C. B. Ad., Cat. Panama Sh., p. 243 (in part). —" *Chiton pulchellus* " Cpr., P. Z. S. 1865, p. 276.—*Callistochiton pulchrior* Cpr., *MSS.*

Not *Callistochiton pulchellus* of Carpenter's *MSS.*—Not *Chiton pulchellus* of d'Orbigny, Voy. dans l'Amér. Mérid., p. 489.

The netted sculpture of the dorsal areas is unlike other species from the western coasts of the Americas. Figures 3–6, drawn by the author, should enable any one to identify the species readily. The small size is also rather characteristic, as well as the profile of the posterior valve (fig. 5.)

I have but little doubt of the identity of Carpenter's *C. pulchrior* (=*C. pulchellus* Cpr., P. Z. S. 1865, p. 276) with the true *C. pulchellus* of Gray. Carpenter separated *pulchrior* from *pulchellus* after studying specimens supposed to be of the latter species sent him by Cuming; but it is clear to me that Cuming's identification was erroneous, and therefore the position taken by Carpenter becomes untenable.

Drawings of the form called *pulchrior*, prepared for Carpenter, are reproduced on my plate 59, figs. 21–26. The sculpture is not well rendered, and if the drawing is accurate, the tail-plate differs somewhat in profile.

Gray's description of *pulchellus* is not as good as Reeve's and his figure (pl. 60, fig. 1) is poor. The detail figure given by Reeve is copied on pl. 60, fig. 2. Gray's description is as follows:

Shell oblong, elongate, slightly keeled, yellowish-white. End valves distantly, unequally, radiately ribbed; lateral areas of the middle valves with two broad, regular ribs; central area closely and deeply punctured. Margin yellowish-white, with very minute bran-like scales. The ribs of the lateral areas are rarely bifid.

Length $\frac{3}{8}$, breadth $\frac{1}{8}$ of an inch. [=about 9 x 4 mill.]

Inhab. Arica, Peru, Rev. W. Hennah, Brit. Mus. (Gray.)

The species described from Arica by d'Orbigny is in all probability the same as Gray's form, but the figures are very poor. The original description is here translated:

C. bicostatus d'Orbigny. (Pl. 59, figs. 43, 44). Shell oblong, swollen and obtuse, entirely whitish. Anterior and posterior valves sculptured with broad, radiating ribs and some concentric lines of growth. Lateral areas of the intermediate valves each ornamented

with two very large, prominent ribs; median areas wide and punctate. Girdle minutely scaly. Length 7 mill. (*Orb.*)

Arica, under stones at low water.

"Allied to *C. pulchellus* of Gray, differing in the granulous and scaly, not smooth, girdle, by the two ribs of the lateral areas instead of three, and by the punctate central areas, which in the other species are striated." (*Orb.*)

It must be remembered that the "*C. pulchellus* of Gray" alluded to by Orbigny, is not the true *pulchellus* of Gray, but some totally different species of *Chætopleura* or of *Tonicia*.

C. SHUTTLEWORTHIANUS Pilsbry, n. sp. Pl. 21, figs. 42, 43, 44, 45, 46.

Shell oval, depressed but *dorsally carinated*, the side-slopes nearly straight; lateral areas strongly raised, bicostate, the ribs nodose; central areas having a coarse raised net-work in the middle, and longitudinally ribbed toward the sides. Girdle broad. *Color of both shell and girdle intense orange yellow.*

The lateral areas bear two strong ribs which bear *stout transverse tubercles*, the intervening spaces being closely granulate. *The central areas have coarse net-like sculpture* (fig. 45), which becomes much finer toward the beaks, and is transformed into a longitudinal costulation at the sides. The front valve has 16 or 17 strong, tuberculate radiating ribs, the whole covered by a fine granulation. *The posterior valve is depressed, having a rather low but acute and slightly posterior mucro, the slope back of it being concave.* It is sculptured similar to the head-valve, except that the concentric sculpture predominates over the radiating.

The interior is flesh-colored; anterior valve with 10, central 1 slit; sutural plates low and rounded; sinus shallow, flat.

Girdle wide, compact, very densely clothed with closely imbricating scales, the terminations of which are not striated, although the basal portions are distinctly grooved (pl. 21, fig. 46.)

Length 14, breadth 9 mill.

Key West, Florida (Henry Hemphill.)

This handsome species constitutes one of the links between *Callistochiton* and *Ischnochiton*, agreeing in the teeth with the latter genus. The sculpture, however, is much more like *Callistochiton pulchellus* than like any *Ischnochiton* known to me; but, on the other hand, the profile of the tail-valve differs utterly from that West Coast species.

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It seems to resemble the unfigured *I. lateritius* Shuttlew. in color and somewhat in sculpture; but Shuttleworth says of his species "*valvis terminalibus subconcentrice lineatus punctatisque; mediis non carinatis*," etc., and this in no way agrees with the species described above.

The type is in the collection of the Academy.

C. ANTIQUUS Reeve. Pl. 59, figs. 29, 30, 31, 32, 34, 35.

Shell oblong-elliptical, moderately convex, obtusely carinated, the side-slopes convex; of a uniform soiled buff, or stained with reddish along the back; sometimes tinged with olive-green.

Valves not beaked. Lateral areas composed of two strongly elevated ribs, bearing compressed grains, the posterior rib wider, its grains denticulating the suture. *Central areas having a honey-comb reticulation near the beaks*, on the sides changing into fine longitudinal riblets with minutely latticed intervals. Anterior valve having 11–12 very strong, rather narrow and acutely granose ribs. Posterior valve depressed, *sloping backward from the front margin, the mucro depressed*, slightly in front of the center; the posterior area having 8–9 strong granose ribs.

Interior bluish-white, sutural plates low, rounded, separated by a broad shallow sinus. Anterior valve having 9, central 1, posterior 9 slits, corresponding to the external ribs; teeth smooth, rather sharp, curved and concave outside as usual in *Callistochiton*. Eaves rather narrow.

Girdle wide, thin, leathery, compactly covered with very small convex and apparently smooth brown scales, having light colored larger scales mingled among them (fig. 34.)

Length 17, breadth 10 mill.; divergence 110°–120°.

Port Molle, Queensland (Coppinger), *Port Jackson, N. S. Wales* (Angas, Brazier, Challenger.)

Chiton antiquus REEVE. Conch. Icon., t. 25, f. 169 (poor).— *Lepidopleurus antiquus* ANGAS, P. Z. S. 1867, p. 223.— *Callistochiton antiquus* CPR. *MS.* and HADDON, Challenger Polyplac., p. 20.— *Chiton* (*Callistochiton*) *antiquus* E. A. SMITH, Zool. Coll. 'Alert' p. 79.— *Callistochiton sarcophagus* CPR., *MS.*

This species has the same style of honey-comb or netted sculpture toward the beaks that *C. pulchellus* and *C. shuttleworthianus* show. A specimen in which the number of ribs on the head valve is increased by splitting to 17, and on the tail valve to 16 is on record;

but the number in front is ordinarily from 10 to 12, behind from 8 to 12. The tail valve is much depressed, as in *C. gabbi.*

Carpenter described a large, fine specimen as *C. sarcophagus,* but upon examining Reeve's type he concluded that it was merely a well developed *antiquus.* The type is in the British Museum.

C. COPPINGERI Smith. Pl. 59, fig. 36.

Shell elongate, greenish-white, stained with a dark green color along each side near the girdle, with a paler indistinct stripe on each side of the central line, the apex of the valves being somewhat livid. Central valves with a straight posterior margin, arched, with only the faintest indication of a carina at the vertex. Lateral areas somewhat raised, with two radiating rows of coarse transverse rugæ, of which the hinder or marginal are the largest. The surface between them is finely granular. Central areas covered with a more or less criss-cross granulation, the granules at the center being very minute, and gradually increasing in size toward the sides, where there is very little of the criss-cross arrangement seen at the vertex, but rather a longitudinal disposition of them. The front valve is minutely granulated and has about twenty fine radiating ridges, here and there some of them bifurcating near the circumference. Posterior valve rather large, concave behind the subcentral mucro, in front of which the surface is sculptured in the same manner as the front of the central valves, as is usual with most, if not all Chitons. The posterior half is finely grained and sparsely covered with pustules of different shapes and sizes. The coarsest being near the margin and the smallest near the center. The insertional plates are thin, with twelve slits in the last, at unequal distances, eleven in the front one, and one on each side of the intermediate valves. The interior is pale bluish, the latter valves having an olive-brown stain radiating from the vertex behind on each side, and the two terminal valves have marks of the same color near the middle.

The girdle is covered with alternately pinkish and dark grayish patches of fine oval compressed imbricating scales, of which those toward the outer margin are much smaller than those near the valves.

Length without girdle 21 millim.; diameter of fifth central plate 8 mill. (*Smith.*)

Port Jackson, Australia (Coppinger.)

Chiton (Callistochiton) coppingeri E. A. SMITH, Rep. Zool. Coll. H. M. S. 'Alert,' p. 80, t. 6, f. E (1884.)

The only published figure of this species is very poor. Smith writes: closely allied to *C. antiquus*, but it is differently and more finely sculptured, and the scales on the mantle are larger.

The type is in the British Museum.

C. ADENENSIS Smith. Pl. 59, fig. 45.

Shell small, depressed, hardly carinated, unicolored pale brownish. *Anterior valve having about* 22 *granulate radiating ribs.* Lateral areas composed of two strong granulate ribs; central areas longitudinally granose-lirate, the liræ more delicate in the middle than at the sides. *Posterior valve having about* 25 *delicate granulate liræ.* Girdle pale brownish, very minutely scaly.

Length 14, breadth 9½ mill. (*Smith.*)

Aden.

Chiton (*Callistochiton*) *adenensis* E. A. SMITH, Proc. Zool. Soc. Lond. 1891, p. 421, t. 33, f. 7.

The sculpture of this species is of the same character as that of *C. antiquus* Reeve, but not quite so pronounced, and the rays of both the terminal valves are more numerous. (*Smith.*)

The type is in the British Museum. The italics of the above description are my own.

C. HETERODON Pilsbry, n. sp. Pl. 60, figs. 11–15.

Shell oblong, rather elevated, carinated, the side-slopes nearly straight; buff-white, sparsely dotted on the ridge with olive-black and having one or two spots of the same on the sides of each valve; the girdle yellowish, having narrow slate-colored bars.

Valves having rather acute but not backward-projecting beaks. *Lateral areas raised, having* 3 *or* 4 *ribs,* being primarily divided by a deep sulcus into two ribs, the posterior of which is again divided; and sometimes the front rib also is split into two, especially on the second valve; the interstices are coarsely pitted, and the posterior rib is ribbed across, *dentating the sutures. The central areas have about* 11 *rather narrow but strong longitudinal riblets on each side of a wider dorsal rib; the interstices nearly smooth. Head valve having* 11 (or 13, by splitting) *strong denticulate ribs. Tail valve narrower than the head-valve, not depressed, the mucro obtuse, post median;* posterior slope convex, having 11 radiating ribs.

Interior pure white. Sutural plates narrow, separated by a square, slightly deticulate sinus, which is distinctly laminate and slightly notched at the corners. Anterior valve having 8, central valves 1,

posterior valve 13 slits; *teeth blunt, finely and deeply pectinated outside and at the edge.* Eaves solid.

Girdle broad, compactly covered with shining, deeply sulcated scales, measuring about one-third of a millim. in breadth, and *the terminal margin of each is smooth* (fig. 13.)

Length about 16, breadth 10 mill.; divergence about 105°.

Red Sea.

This species has far fewer ribs on the terminal valves than *C. adenensis* Smith, although the lateral areas have more ribs. The girdle scales are coarser than in other species, and they have the peculiarity noted in *C. shuttleworthianus,* of being smooth at the distal end. I have seen no Chitons of other genera having this feature. The second valve has several slightly diverging riblets at the front of the dorsal area. The teeth are as deeply pectinated as in any species of typical *Chiton* or *Acanthopleura;* and it is by no means impossible that the species belongs to the former genus. I have preferred to retain it in *Callistochiton* on account of the peculiar sculpture, and the relation in which the slits stand to the ribs.

The type is in the collection of the Academy.

Var. SAVIGNYI Pilsbry. Pl. 60, fig. 16.

This form is known to me by Savigny's figures, which indicate a species closely resembling the last. The head valve has 11, *the lateral areas two ribs;* the tail valve is smaller, having 9 ribs; central areas with about 9 ribs on each side, and a rather wide smooth tract in the middle. Scales of the girdle sulcate, with smooth outer edges.

SAVIGNY, Descript. de l'Aegypte, Gastérop., t. 3, f. 8·1, 8·2, 8·3.

Genus XXIV. NUTTALLINA Carpenter, 1879.

=*Nuttallina* plus *Middendorfia* plus *Beanella* Cpr.

Valves exposed, granulated, the lateral areas having 2, head valve numerous low radiating ribs; insertion-plates sharp, the slits corresponding in position to external ribs. Mucro behind the middle, the posterior teeth directed forward. Eaves and sinus very spongy. Girdle varying from spiny to scaly.

This well-defined genus probably has the same apparently anomalous distribution as the coral-red Leptothyras; species being found in the Mediterranean, the Japanese Seas, and the coast of Cali-

fornia. *Nuttallina* is divisible into two closely allied sections or subgenera, as follows:

Subgenus NUTTALLINA *s. str.* Side-slits two in each valve, the posterior one generally subobsolete, but indicated by a porous slit-ray. Teeth hardly or not thickened at the edges of the slits; girdle with minute, often chaffy spinelets and longer round spines.

Subgenus MIDDENDORFFIA Cpr. Side-slits single. Teeth more or less thickened at the edges; girdle clothed with minute striated flattened scales and having a marginal row of flat striated bristles.

Subgenus NUTTALLINA Carpenter (restricted.)

Nuttallina CPR., Table of Reg. Chitons, 1873.—DALL, (Amer. Journ. Conch. vii, p. 134), Proc. U. S. Nat. Mus. 1878, p. 333 (Feb. 14, 1879.)

Valves exposed, granulated, having long smooth sharp teeth; the slits of the median valves obsoletely doubled, those of the anterior valve corresponding in position to the external ribs, the teeth not thickened at the edges of the slits; mucro of posterior valve posterior, terminal but not marginal; teeth of posterior valve short, chisel-shaped, directed forward. Eaves and sinus spongy. Girdle bearing short, rigid spines. Gills extending the whole length of the foot. Type *N. scabra* Cpr.=*Ch. californicus* (Nutt.) Rve.

The shell in this genus resembles that of typical *Acanthopleura* (*A. spinosa* Brug.) in the elongated valves, double slitting of the median valves, and the spinose girdle. It differs in the smoothness of the sharp teeth and the spongy sinus,—characters of much greater importance than those first enumerated. The likeness of *Nuttallina* to *Acanthopleura* is, in fact, merely one of analogy, having no meaning deeper than that story of the development of different stocks along parallel lines, repeated so often in the history of Chitons. In its fundamental characters, *Nuttallina* agrees with *Ceratozona;* but the more shelly texture of the girdle-spines, the spongy sinus, and propless teeth afford sufficient ground for generic distinction.

Authors and collectors have generally recognized but one California species; but there seem to be two. It is useless to try to study them without separating the valves, as the specific characters are not very apparent in specimens preserved in the ordinary manner.

The white spines are often striated when young, as are the scale-like spines of *Middendorffia*.

N. CALIFORNICA Nuttall. Pl. 54, figs. 23, 24; pl. 56, fig. 12, 13, 14, 15, 16, 17, 18.

Shell elongated, more than twice as long as wide, moderately elevated, carinated or somewhat rounded. Surface finely corrugated-granular, lusterless; color dark brown, dark olive-brown or blackish, unicolored or having one or three whitish stripes along the summit of the second valve.

Median valves strongly beaked, v-shaped, the anterior margin of the tegmentum trilobed; *having a smooth shining rounded dorsal ridge* (sometimes obsolete and often eroded), *bounded by a pair of diverging, shallow furrows; the entire sides of the valves (pleura and lateral areas) closely granulated,* the granules irregularly arranged in rows. Lateral areas not raised but indicated by a low curved diagonal rib, behind which and parallel to it, there is a shallow sulcus. Anterior valve having 11 low rounded radiating ribs, the entire surface granulated. Posterior valve depressed, small, the *mucro posterior and terminal, projecting beyond the posterior margin of the eaves.*

Interior bluish, sometimes stained with blackish at jugum and bases of the sutural plates. *Sutural plates very long,* separated by a *wide, deep, square sinus; behind which is a punctate and laminate area.* Anterior valve having 11 or 10, median valves with two slits, or at least two punctulate slit-rays, the posterior slit being usually indistinct or wanting from the more or less complete obsolescence of the posterior tooth; teeth sharp, smooth, long, not thickened at the edges of the slits. Posterior valve having 8–9 slits, the teeth chisel-shaped, sharp, smooth, *very strongly directed forward.* Eaves narrow, spongy.

Girdle closely covered with short, rigid calcareo-corneous spinelets, *mostly of a scorched brown color* with a few white spines intermingled (pl. 54, fig. 24.)

Length 37, breadth 15 mill. (Large specimen from Monterey.)

Length 26, breadth 13½ mill. (Specimen collected by Nuttall.)

Vancouver Island south to Piedras Blancas, near S. Simeon, San Luis Obispo Co., California.

Chiton californicus NUTTALL in Brit. Mus. and Mus. Phila. Acad.—REEVE, Conch. Icon., pl. xvi, fig. 89 (March, 1847).—*Nut-*

tallina scabra Cpr., *MS.* and of Dall, Amer. Journ. Conch. vii, p. 134; Proc. U. S. Nat. Mus. 1878, p. 333.—*Acanthopleura scabra* Cpr., Rep. Brit. Asso. 1863, p. 649.—Stearns, Proc. Calif. Acad. iii, p. 346.—*Nuttalliana scabra* Keep, West Coast Shells, p. 108, f. 96 (1887.) Not *Chiton scaber* Reeve.

This is the form which has generally been called "*N. scabra.*" Reeve's figure is not good, being drawn from a short specimen abnormally shortened by contraction. It should be noted that the shortest specimen in the large suite before me is also one of those collected by Nuttall, who presented a complete set of his Californian shells to the Academy.

In this species the individual valves are longer than in the following form, but on account of their deep imbrication the difference is not in most cases noticeable until the shell is dissected. The girdle is much more densely clothed with spinelets.

The areas of distribution seem to be separated, the true *californica* extending southward past Monterey Bay,—the southern out-post of so many species of the Columbian district,—to near S. Simeon, S. Luis Obispo Co. The other species, *scabra*, has not been noticed north of Sta. Barbara Island, and San Diego on the mainland. There is still a considerable stretch of coast from which we have no record, or at least no record in which the two forms are discriminated. This coast should be searched for intermediate forms.

Dall gives the following notes on the station of this form: This singular species (not yet obtained from Alaska, but which will probably be found there), like some *Litorinas*, seems habitually to prefer positions where it can at most be reached by the spray in storms, on exposed headlands, where the breeze comes in damp and cool from the sea. The pointed valves overlap each other so much that when the creature is curled up they project from the girdle, giving a pectinated outline, unusual in Chitons. The valves are almost always eroded, even the prominent mucro is often hollowed out, and the sculpture can rarely be seen except in young specimens. The color is grayish or brownish, with whitish streaks; the girdle has the aspect of dead brownish-black moss, sometimes with ashy spots at the sutures.

N. scabra Reeve. Pl. 54, figs. 21, 22; plate 56, figs. 19, 20.

Shell similar to N. californica, but having the individual valves very much shorter in proportion to their width; the outer layer of the median valves produced at the sides anteriorly, curving broadly

forward and laterally upon the sutural plates; the median ridge and sulci more or less obsolete. Tail valve shorter, with less posterior mucro. Color of valves lighter, more variegated.

Girdle rusty brown or alternately blackish and white; bearing rather sparsely scattered white spike-like spines, sometimes having one or two at each suture. (Pl. 54, fig. 21). Length 29, breadth 13 mill.

Santa Barbara Is. and San Diego to between Scammon's Lagoon and Pta. de Abreojos, Lower California.

Chiton scaber REEVE, Conch. Icon., t. 17, f. 106 (March, 1847).—*Acanthopleura fluxa* CPR., Suppl. Rep. Brit. Asso. 1863, p. 649; Proc. Cal. Acad. iii, p. 211, (1865.)

This species has hitherto been confused with the preceding by most collectors. Carpenter, however, distinguished it, and gave the name *fluxa*. Although the individual valves are much shorter in this species than in *N. californica*, they overlap much less, so that the total length of the animal is about the same in the two species. The elevation is about equal also, but in *californica* the girdle is generally wider at the sides, especially in old specimens. In size, individuals of the northern species considerably exceed any of the southern I have seen, although the majority of specimens do not differ much.

N. ALTERNATA Sowerby. Pl. 54, figs. 25, 26, 27.

Shell elongated, subdepressed, very minutely granulated; lightly keeled by a central rib; lateral areas separated by a lateral rib. Anterior valve radiately ribbed; posterior valve small.

Girdle furnished with minute spines, alternately banded black and white. Length 15, breadth 8½ mill.

Narrow, rather flat, minutely granulated; the first valve radiated with slightly raised ribs, the intermediate have each three faint ribs, one dorsal, the other two lateral; the last is very small, with a nearly terminal apex. The margin is covered with very minute spines, in alternate patches of black and white; general color, dark olive-green. (Sowb.)

Japan (Mus. Cuming).

Chiton alternatus SOWB., Mag. of Nat. Hist., 1840, p. 288; Conch. Illustr., f. 141.

This form has not been noticed by subsequent authors. It seems to agree with the preceding species in the dorsal and lateral ribs, and also those upon the anterior valve; but as the interior is unknown, its reference to *Nuttallina* is provisional.

Subgenus MIDDENDORFFIA Carpenter, 1882.

Middendorfia CPR., *MS.* and in DALL, Proc. U. S. Nat. Mus., 1881, pp. 284, 287, type *Chiton polii* Phil. *non* Desh., (Jan. 20, 1882.)—*Dawsonia* CPR. 1873, preöc., same type.—*Beania* CPR. *MS.*, not of Johnstone.—*Beanella* DALL, Proc. U. S. Nat. Mus. 1881, pp. 284, 287, type *C. pseudorissoi* CPR. ined., in Mus. Cuming no. 51.

Valves exposed, rather square and short, granose outside with low ribs at lateral areas and on head-valve. Insertion plates rather sharp, not notably rugose, the teeth more or less thickened outside at the slit-edges; slits of head-valve corresponding in position to external ribs. Tail valve small with mucro behind the center, the teeth directed forward, eaves and sinus coarsely spongy. Girdle narrow, compactly covered with a pavement of minute striated scales and spinose at the edge. Gills extending forward over three-fourths the length of the foot. Type *Ch. cinereus* Poli, not Linn.

This subgenus agrees with *Nuttallina* in the markedly porous or spongy texture of eaves and sinus, in the external sculpture, and in the forms of the insertion-teeth, except that in *Middendorffia* these are thickened at the slit-edges. It differs from Nuttallina in the rather flattened scale-like, rather than spine-like girdle appendages but the younger spines of *Nutallina scabra*, when examined under a strong power are often seen to be striated, appearing like finely fluted ivory pillars; and in some specimens of the same species there is a marked tendency to form a marginal fringe of longer spines. The differences between the West American and Mediterranean forms are therefore not great, being confined to (*a*) the girdle covering, which often varies as much in closely allied species, such as *Ischnochiton conspicuus* and *I. acrior*, or *Chætopleura peruviana* and *C. hennahi*, and (*b*) the thickened tooth-edges, which varies considerable in *Middendorffia* and fails as a generic character in *Ceratozona* and some other groups.

It should be noted that in *Middendorffia* the true structure and especially the sculpturing of the girdle-scales often cannot be satisfactorily observed without a compound microscope; and a magnifi-

cation of from 50 to 100 diameters is necessary to demonstrate it in many specimens.

N. CINEREA Poli. Pl. 54, figs. 28–33.

Shell oval, moderately elevated, not carinated, the side slopes straight. Surface lusterless, generally encrusted with calcareous growths, gray or greenish blotched with black or dark green with some light markings or light valves.

The median valves are beaked when young, but eroded and hardly beaked when adult, the *lateral areas not raised but marked by two low wide rounded ribs* with a shallow depression between them; one rib diagonal, the other at the posterior border. *Entire surface of all valves evenly covered with comparatively coarse granules.* Anterior valve having 8 or 9 low rounded radiating ribs. *Posterior valve very small,* the mucro somewhat behind the center, the slope behind it straight; *posterior margin emarginate* (as in Eudoxochiton, p. 193.)

Interior bluish in the middle, olive-greenish at the sides. *Sinus rather deep and angular, very porous or spongy.* A more or less distinct laminate triangle extending from sinus to beak. Anterior valve having 8 or 9 slits corresponding in position to the external ribs; the slits are very short, but are continued as grooves to the eaves outside; median valves with 1 slit; the anterior teeth nearly smooth, *distinctly thickened* or "propped" outside at the slits; posterior valve having slits, the teeth rather stumpy, *short in the middle behind,* longer and directed forward at the sides. Eaves rather wide and coarsely spongy.

Girdle narrow, alternately dark and light, compactly covered with small, subcircular or irregularly polygonal scales, striated on the convex outer surface, crowded together; the margin beset with a series of slightly flattened, striated translucent bristles, (figs. 31, 33).

Length 14, breadth 8 mill.

Length 20, breadth 12 mill.

Entire Mediterranean and Adriatic Seas; Atlantic Ocean at Cadiz, Spain. Littoral zone.

Chiton cinereus (+ *Lophyrus melphictensis*) POLI, Test. utr. Sicil. i, multivalvia p. 4, t. 3, f. 1–20, (1791). Not *C. cinereus* Linn.—*C. caprearm* SCACCHI, Cat. Conch. Regni Neapolitani, p. 9 (1836) teste Monts.—*C. caprearum* Scac., BUG., DAUTZ. and DOLLFUS, Moll. Mar. Rouss. i, p. 492, t. 61, f. 7–9; t. 62, f. 1 (1886).—

Ch. polii PHILIPPI, Enum. Moll. Sicil. i, p. 106 (1836); ii, p. 83 (1844), and of most subsequent authors; not *Ch. polii* Desh. 1832. —*Ch. crenulatus* LOCARD, Coq. Mar. des Cotes de France, p. 233. (1892), and perhaps *C. crenulatus* Risso Eur. Merid. p. 267.—*Chiton decipiens* TIBERI, Bull. Soc. Mal. Ital. iii, p. 141 (1877).—*Chiton corrugatus* REEVE Conch. Icon., t. 28, f. 185 (1848).

Distinguished from other Mediterranean species by the finely granose-scaly sculpture covering the entire surface, with two low ribs at the lateral areas and 8 or 9 on the head-valve. The girdle is composed of short striated scales crowded together, producing a "cobble-stone pavement" surface. The true nature of the scales appears only when highly magnified. The nomenclature of the species is peculiarly involved, like that of most Mediterranean Chitons. Poli believed it to be the *cinereus* of Linnæus, but Philippi distinguished it from that and gave the name *Polii*, which unfortunately had been some years before bestowed by Deshayes upon another species. Monterosato claims to have identified it with *Ch. caprearum* ("*caprearm*") of Scacchi, by examination of a type in the Petit collection; but the description given by Scacchi is inadequate. Scacchi says: "*Chiton caprearm* [sic] *Nobis. Clypeis 8 tuberculatis virescentibus, fascia marginali squamoso-muricata, perbelle ciliata. Longus lin. 6, latus lin. 4¼. Caprearum scopulos incolit.*" Locard identifies it with *crenulatus* Risso, the original description of which follows: "*C. crenulatus. Dorso segmentis omnibus cinereis crenulatis, Long. 17 mill. Penn. Br. Zool. 4, XXXVI, 3, Pol., 4, iii, ?*" Of course this *may* be the present species, but the wretched description, without a figure is quite unacceptable. Tiberi proposed the name *Ch. decipiens* as a substitute for *polii* Phil. not Desh. The locality of Reeve's *Ch. corrugatus* is not known, but the description and figures render its identity reasonably certain, and Carpenter declares the types to be young *polii* Ph. In the midst of so many conflicting names and opinions I prefer to retain the name given by Poli. His description is infinitely better than any of the later ones mentioned above. Indeed Poli's work upon this species is wonderful for his time, and with such an example before them it is surprising that so many Mediterranean naturalists have left such miserable work.

It is needless to say that the *Chiton cinereus* of Linné belongs to a genus which must be admitted by all naturalists who examine the subject, to be perfectly distinct.

The representation of the coarse pores of the eaves in fig. 28 causes the teeth to appear pectinated, which is by no means the case.

Var. *pseudorissoi* Cpr. Teeth of insertion hardly thickened at the edges; mucro submedian; girdle scales elongated, flattened, striated.

Malta.

The type is no. 51 of Mus. Cuming. Carpenter, after examining more material, decided that this form was specifically identical with the *Ch. polii* Phil. His type specimen is a young shell. Not having seen it, I am unable to tell whether all of the scales, or only those at the edge are elongated. In either case the subgeneric name *Beania* or *Beanella* falls as a synonym.

Genus XXV. CRASPEDOCHITON Shuttleworth, 1853.

Craspedochiton Shuttlew., Bern. Mittheil. 1853, p. 67. Type *Ch. laqueatus.*

Valves exposed, slightly immersed, granulated; with five low ribs on the head-valve; insertion plates sharp-edged; those of anterior valve long, strongly grooved inside and out, having slits at the positions of the external ribs; median valves having the insertion plates thin, sharp, 1-slit; posterior valve with subcentral mucro, teeth short, grooved. Girdle corneous, very minutely roughened.

The characters of eaves and sinus are unknown to me. The external sculpture reminds one of *Nuttallina*, which differs in the posterior mucro, etc. The sharp-edged insertion plates, and the correspondence of slits to external ribs show clearly that this genus does not belong in the neigborhood of *Chiton*, *Tonicia*, etc., where Carpenter placed it, but with the genera here accompanying it which share these peculiarities.

C. laqueatus Sowerby. Pl. 39, figs. 42–51; pl. 44, fig. 68.

Shell ovate, depressed, granulated; pale, tawny or greenish, maculated with purple or green; the dorsal rib purple.

Anterior valve having five low ribs, median valves squared at the ends, and having the sculpture often worn from the median ridge, which is wedge-shaped on each valve, the wedge being composed of about six truncated, somewhat wedged segments, and on each side there are oblique, irregular ridges. Posterior valve having the mucro central and very little raised.

Interior: Anterior valve (figs. 43, 44, 45) considerably thickened within, and shallowly grooved radially; the insertion plate stout at the base, acute at the edge, and furrowed both inside and out, the edge consequently being roughly crenulated; slits 5, corresponding in position to the external ribs. Median valves (figs. 46, 47, 48) having broad and thin insertion plates, which are smooth-edged, and only very finely striated. Posterior valve (figs. 49, 50, 51) having the insertion plate very short, thick, moderately sharp-edged coarsely grooved within and without, and roughly crenulated on the margin. When viewed from above (the valve resting upon a flat surface) the teeth are not visible, and all touch the surface, there being no upward wave posteriorly.

Girdle coriaceous (or perhaps better, pithy) and almost smooth.

Length 13¾, breadth 11¼ mill.

Calapan, Island of Mindoro, Philippines, in coarse sand among small stones, in 9 fms. (Cuming.)

Chiton laqueatus Sowb., P. Z. S. 1841, p. 104.—Reeve, Conch. Icon., t. 20, f. 135.

The above description is mainly compiled from details furnished by Mr. E. A. Smith of the British Museum, who also drew figures 42–51 from one of the original specimens. The scale-like granules are said to be represented somewhat too small on the figures. Sowerby remarks that the four or five central valves in several specimens are nearly covered by a dark purple color, the two last patched with green, and the first nearly white, but subject to some variations. Shuttleworth describes the girdle "*limbus corneus, minutissime asperulus,*" but Smith says it is nearly smooth in the British Museum specimens, and the insertion plates are visible through it, as shown in fig. 42.

Genus XXVI. ANGASIA Carpenter, 1882.

Angasia Cpr., Table Reg. Chitons 1873; and in Dall, Proc. U. S. Nat. Mus., 1881, p. 283, 286, 289, 290 (Jan. 20, 1882).—*Augasia* Scudder, Nomencl. Zool. p. 38 (typog. err).

Valves outwardly and within like those of *Chætopleura,* but the eaves small; girdle minutely scaly-pilose, and furnished with tufts of hairs at the sutures. Type *A. tetrica* Cpr.

I have seen no specimen of this form, which I believe to be related to *Craspedochiton.* Carpenter writes as follows:

"This genus differs from *Callistoplax* in having the eaves short, the teeth straight (though frequently propped outside, as in *Callochiton*), the mantle crowded with minute horny scales or rudimentary bristles and furnished with pore-bunches round the sutures. The anterior valves is 5 slit, as in *Acanthochites*, but that may be only a specific peculiarity. The *Hanleya variabilis* Ad. and Ang. P. Z. S. 1864, p. 194, probably belongs to this genus, but has not been dissected. Angasia is known at once from *Hanleya* by the presence of insertion teeth; and from *Placiphora* by the regular articulation of the tail plate. If the genera be grouped according to the mantle-pores, *Angasia* will represent *Chætopleura* in the tufted series, as *Callistoplax* represents *Callistochiton*."

A. TETRICA Carpenter, n. sp. Pl. 61, figs 27–32 (sculpture not represented.)

Shell oval, greenish-ashen, rather elevated, the jugum acute; mucro slightly in front of the middle, slightly elevated; valves squared, beaked; the terminal ones much flattened. Jugular area obscurely tricostate; lateral areas obscurely defined by a diagonal angle; anterior valve somewhat obsoletely five-angled; the whole surface very closely sculptured with wide, irregular, flattened sometimes striated pebbles, smaller toward the dorsal ridge.

Interior: Posterior valve having 9–13 slits, the teeth small, radially flattened, rugose outside and propped, generally bilobate; anterior valve having 5 slits, the teeth more acute, roughened outside, slightly propped; central valves with one slit, the teeth acute, rugose outside, conspicuously thickened or propped at the sides of the slit; eaves small; sinus narrow, short, smooth; sutural plates separated.

Girdle narrow, leathery, with very close and very minute corneous scales; at the sutures and around the end valves there are bunches composed of a few short spicules, and there are a few scattered spicules also.

Length 15, breadth 9½ mill.; divergence 120° (*Cpr.*)

Ceylon (Mus. Cuming, No. 83).

A. tetrica CPR. *MS.*, and in DALL, Proc. U. S. Nat. Mus., 1881, p. 286 (no description).

A common observer might describe the mantle simply as rough and leathery, so minute are its remarkable features. The same

structure, but without the pores, characterizes some species herein referred to *Chætopleura*. The posterior valve somewhat resembles an irregular *Maugerella;* the anterior valve is strictly Acanthochitoid. Both of these are flattened, while the ridge is sharp on the central valves. (*Cpr.*)

Var. CALCULOSA Cpr.

Shell externally very similar to *A. tetrica*, but roseate; jugal areas distinctly tricostate; anterior valve distinctly five-angled; pebble-sculpture smoother. Interior: posterior valve normal, with 5 slits, the teeth all acute, but slightly roughened, hardly propped; sinus narrow, deep, smooth, flat. Bunches of spicules minute, inconspicuous (*Cpr.*)

Philippines (Mus. Cuming no. 79, part.)

Angasia (*? tetrica var.*) *calculosa* CPR., *MS.*

"The insertion plates of this shell offer a marked contrast to the Cingalese shell, being strictly like Ischnochiton (with shortened eaves) throughout. But one specimen, after an anterior fracture, has mended it with distinctly rugulose teeth, and made its posterior teeth propped and lobed, showing a close connexion between the two forms. It is probable that Mr. Cuming's specimens from the two localities had been intermixed. The tufts could scarcely be detected in shriveled specimens" (*Cpr.*)

Genus XXVII. CALLISTOPLAX Carpenter, 1882.

Callistoplax CPR., Table of Regular Chitons, 1873.—Dall, Proc. U. S. Nat. Mus. 1881, p. 283, 286 (Jan. 20, 1882).—TRYON, Struct. and Syst. Conch. ii, p. 342.

Valves outwardly and within as in *Callistochiton*. Girdle naked except for a series of bristle-bearing pores.

The present genus is one of the very few which rest entirely upon characters of the girdle; but so different is this from that of *Callistochiton*, not only in the presence of pores, but in the entire absence of scales, that no course seems open but to treat the group as of generic value.

C. RETUSUS Sowerby. Pl. 61, figs. 17–26.

Shell small, subelongate, slightly elevated, the jugum acute; mucro median, very obtuse, elevated in adult specimens. Jugal area smoothish, granulose, in the adult having a few acute longitu-

dinal lirulæ; central areas with about 10 rugulose-granose liræ on each side, perpendicular to the diagonal line, the interstices cancellated. Lateral areas having two very strong rounded ribs, the front one stronger, separated by a narrow sulcus, and concentrically wrinkle-granose and very minutely granulose; sutures with a series of imbricating granules. Anterior valve having 7 ribs, of which the posterior ones (as in the median valves), bifurcate, and are imbricated along the sutures; posterior valve in the young shell having 6 ribs, all of these bifurcate, and the anterior ones split twice, making 14 delicate, flattened ribs, which tend forward somewhat.

Interior: the posterior valve, in a young specimen has about 11 slits, the teeth curved in harmony with the external ribs, and directed radially outward; in the adult there are about 12 slits, the teeth solid, directed somewhat forward, rugose-costate at the margins, concave in the middle, the eaves very heavily callous. Anterior valve having 7–8 slits, situated in the middle of the ribs, the teeth following the curvature of the outer margin, acute. Central valves with 1 slit, teeth excurved, eaves wide, pectinated, spongy. Sinus narrow, deep, narrowly slit on each side of the lamina, and sometimes denticulated by the external sculpture.

Girdle narrow, smooth, thin, having 40–53 bunches of long, corneous hairs around the margin, hardly sutural (figs. 23, 24).

Length 14½, breadth 8 mill.; divergence 120°.

Guacomayo and Puerto Portrero (Cuming); *China Seas* (Cuming.)

Chiton retusus Sowb. P. Z. S. 1832, p. 28, Conch. Illustr. f. 22.—Reeve, Conch. Icon., t. 17, f. 99.—*Plaxiphora retusa* H. & A. Ad. Genera Rec. Moll. i, p. 481.—*Callistoplax retusa* Cpr. *MS.* and in Dall, Proc. U. S. Nat. Mus. 1881, p. 286.

The locality "China Seas" given by Cuming to Carpenter, is probably wrong, that originally given by Sowerby being much more worthy of confidence. The above description is from Carpenter's *MS.*

Figures 17–23 represent a young specimen; in the adult the ribs become more numerous and the tail-plate more "Acanthoid" in appearance (figs. 25, 26).

Genus XXVIII. CERATOZONA Dall, 1882.

Ceratophorus Cpr., Table of Regular Chitons, 1873, type *C. guildingi* Rve. Not of Diesing, 1850.—*Ceratozona* Dall, Proc. U. S. Nat. Mus. 1881, p. 283, 286 (Jan. 20, 1882).—*Newcombia* Cpr., *MS.*, type *C. setosus* Sowb. Not *Newcombia* Pfr., Malak. Bl. i, p. 117, 1854.

Valves strong, exposed. Insertion plates of anterior valve long, sharp, rugose outside, thickened at the slits, which correspond in position to the external ribs; median valves with similar propped teeth; tail valve having the teeth thick, shorter, rugose, sinus solid. Girdle tough, bearing peculiar corneous spines, similar in substance to itself, generally sparsely bunched, at the sutures. The gills extend the entire length of the foot. Type *C. guildingi* Reeve = *C. rugosa* Sowb.

Shuttleworth may readily be excused for grouping the type of this genus in *Chætopleura*. Compared with *Ch. hennahi* it is seen that both have the teeth sharp, and rugose outside; both have the eaves solid or occasionally with a row of minute pores along the outer bases of the teeth; and finally both have horny spinelets on the girdle. But in *Ceratozona* the insertion teeth are thickened at the slits which correspond in position to the riblets of the exterior; the valves are much more firmly held in the tough girdle, and the appendages of the latter are much more deeply inserted in its substance. If we examine an alcoholic example of *Chætopleura hennahi* we find that the cuticle of the girdle peels off readily, bringing with it all the spinelets, which leave shallow pits in the fleshy substance of the girdle; but in *Ceratozona*, only the smaller hairs are thus readily removed, the larger ones being deeply and very intimately attached. Moreover, in most specimens, a pair, or a small bunch of spines, may be detected near each of the sutures; but this character is often obscure or even wholly obsolete. From *Nuttallina* this group differs in the solidity of the sinus, the less posterior mucro, generally rugose and "propped" teeth, and the peculiar girdle-spines.

C. rugosa Sowerby. Pl. 61, figs. 33–37, 41–45.

Shell oblong, rather convex, the back broadly arched. Surface generally much eroded, green, olive or slate-blackish on the sides, the central areas whitish along the middle, flamed with blackish at the sides, or green there; tail valve having a broad pink ray behind.

The valves are strong, and when not eroded they are somewhat beaked. Lateral areas hardly raised, but defined by a strong rounded rib, sometimes with a lower wide rib behind; having a sculpture of irregular wavy wrinkles over ribs and interval, and also upon the sides of the central areas. Head-valve having about 11 low radiating ribs and superficially waved concentrically. Tail valve rather depressed with a subcentral, slightly projecting mucro, the area behind it obsoletely radiated.

Interior blue-green, varying in intensity. Sutural plates moderate, separated by a rather wide smooth sinus. Anterior valve having 7–10 slits, the teeth long, acute, slightly rugose outside and denticulate at the edge, generally thickened or propped very strongly along the slits; central valves with 1 slit, the teeth much thickened at the edges of the slit; posterior valve having 8–10 slits, the teeth much shorter and blunter than in front, wedge-shaped, denticulate at the edge, not perceptibly propped or thickened along the slits. Eaves very narrow, having a single series of pores along the bases of the teeth.

Girdle very tenacious, rather wide, yellowish, armed with numerous corneous, yellow rather long and pointed spines, most numerous around the edge, and in most specimens showing a bunch of several at each suture; among these larger spines, slender flexible beards are scattered (fig. 35).

Length 40, breadth 25 mill.; generally smaller.

Jupiter Inlet, east coast of Florida (G. W. Webster *et al.*) *to Jamaica* (C. B. Ad., Johnson & Fox); *Porto Rico* (Blauner); *St. Vincent and Trinidad* (Guilding).

Chiton rugosus (Gray) Sowerby, Conchol. Illustr. no. 6, fig. 49, (1841 ?).—Reeve, Conch. Icon., t. 18, f. 115 (April 1847).—*Chiton* (*Chætopleura*) *rugosa* Sowb, Shuttl., Bern. Mittheil. 1853, p. 78.—*Chiton squalidus* C. B. Ad., Proc. Bost. Soc. Nat. Hist., ii, p. 8, (Jan. 1845).—*Chiton guildingii* Reeve, Conch. Icon., t. 21, f. 138 (May, 1847).—*Ceratophorus guildingi* Cpr.—*Ceratozona guildingi* Dall, Catal. Mar. Moll., S. E. U. S. p. 172.—*Ch. bicolor* (C. B. Ad.) Gray, P. Z. S. 1847, p. 67.

This species is not likely to be confused with any except the next. The valves are rather strong and blue-green inside, sometimes very pale. The girdle is of a conspicuous horny yellow color when scrubbed as in most cabinet specimens, but is dull and dark in the natural condition. The horny, curved bristles are both fine and

coarse, but the more delicate ones are easily lost. The pore-bunches at the sutures are rarely conspicuous, and often cannot be made out without the aid of a lens and a lively imagination; and this fact somewhat impairs their value as a generic character. Nearly all of the adult specimens I have seen are very much eroded.

Some recent authors have used the name *guildingi* Reeve, for this species; it is not easy to see why, for Sowerby and Adams both preceded the author of the Iconica. The original figure of *guildingi* is copied on my plate, fig. 37. The sculpture varies a good deal. Fig. 36 is drawn from one of the most strongly sculptured specimens I have seen, from Jupiter Inlet, Fla. Fig. 34 is from Sta. Cruz., of the Virgin group, being drawn from a specimen colored exactly like Sowerby's original figure of *rugosus* (fig. 33). In this shell the teeth are less propped and the eaves narrower than in the Florida examples. Fig. 35 is from a Jamaica specimen.

I have seen no specimen with the mucro so posterior as it is shown in Carpenter's figure (fig. 41); all I have seen resemble fig. 39.

C. SETOSA Sowerby. Pl. 61, figs. 40, 38, 39.

Shell oblong-oval, ashy-greenish, scabrous; front valve, lateral areas and posterior valve radially sulcate. Marginal ligament setose, the setæ rather short and close.

Length 32½, breadth 15 mill. (Sowb).

Guacomayo, Central America (Cuming).

Chiton setosus SOWB., P. Z. S. 1832, p. 27; Conch. Illustr. f. 19.—REEVE, Conch. Icon., f. 100. Not *C. setosus* Beechey's Voy. 'Blossom' t. 41. f. 17,=*Mopalia*. Not *Ch. setosus* Tiles, Mem. Ac. S. Pét. ix, p. 484 (1824).

This species is very distinct from *C. setiger* King, which it in some degree resembles. The bristles around the edge are much shorter, thicker and more closely set. (Sowb).

Carpenter has had figures of the interior and tail valve prepared, and I have copied them in my figs. 38, 39. I have seen no species of this sort from the Pacific side of the isthmus, and I am therefore not prepared to say what relation *setosa* sustains toward *rugosa*, the West Indian form. Fig. 40 is a copy of Sowerby's original figure of *setosus*.

Family MOPALIIDÆ Pilsbry.

Placiphoroidea (part) and *Mopaloidea* (part) CPR.

Chitons in which the valves are divided in the normal manner into lateral and central areas; the teeth of insertion are not pectinated; and the posterior valve has a posterior-median sinus, with one slit on each side or none. The girdle is more or less hairy, never scaly. Gill row as long as the foot.

The normal number of slits in the anterior valve is 8; but this is often increased or diminished by splitting or fusion of one or two teeth. The slits correspond in position to external ribs, as in the last subfamily. In certain forms (*Placiphorella, Placophoropsis*) the number of anterior slits is abnormally multiplied. The intermediate and posterior valves have not more than 1 well developed slit on each side, and even this is lacking in the tail valve of *Plaxiphora.*

The girdle clings more tenaciously to the teeth than in most chitons, being like that of *Ceratozona.* It is frequently provided with *pores* at the sutures, each pore generally bearing two or several bristles or hairs; but the presence or absence of these pores is in no case of more than specific value, and in some cases I have found it to be a mutable feature among individuals of the same species.

The present family is in no manner identical with that so named by Dall, or with Carpenter's division of similar name; nor is it in any sense equal to the *Placophoridæ* of Dall, *Placiphoroidea* Cpr. These Carpenterian divisions of the "Irregular Chitons" are very artificial, just as the primary division of the group into "Regular" and "Irregular" forms is artificial.

The ancestors of Mopaliidæ were *Callistoplacinæ,* probably not very different from the recent genus *Ceratozona.*

Key to the genera of Mopaliidæ.

a. Posterior valve having a slit on each side of the median sinus.

b. Shell oblong; girdle narrower in front than at the sides, its hairs smooth; teeth of insertion not lobed. MOPALIA.

bb. Shell rounded-oval; girdle expanded and broadest in front, its hairs scaly; teeth of insertion more or less lobed. PLACIPHORELLA.

aa. Posterior valve having a median tail-sinus but no slits. PLAXIPHORA.

Genus XXIX. MOPALIA Gray, 1847.

Mopalia Gray, P. Z. S. 1847, pp. 65, 69, 169, (exclusive of section * *). Type *Ch. hindsii*.—Carpenter *MS.* and in *Dall*, Proc. U. S. Nat. Mus., 1878, p. 303.—*Molpalia* Gray, Guide Syst. Dist. Moll. B. M., p. 184 (err. typ.), 1857.—Gould, Otia, p. 118.—*Osteochiton* Dall, Proc. U. S. Nat. Mus. 1886, p. 211. Type *M. sinuata* Cpr.

Valves normally proportioned, transverse, not beaked, exposed, the girdle somewhat encroaching at the sutures. Sinus small; insertion-plate of anterior valve rather long, sharp, slit into nearly smooth teeth which are somewhat thickened at the edges of the slits, the latter being normally 8 in number and corresponding in position to external ribs. Median valves having similar 1–slit insertion-plates. Posterior valve depressed, the mucro post-median, insertion plate rather sharp, smooth or roughened, *having an oblique slit on each side* (rarely doubled) and a larger sinus in the middle behind. Girdle wider at the sides than in front, leathery, more or less hairy, the hairs simple; with or without sutural pores.

This genus is known only from the shores of the northern Pacific, extending from Lower California to Alaska and Japan. It may be regarded as the most primitive of the existing genera of *Mopaliidæ; Placiphorella*, and *Plaxiphora* being special modifications of the *Mopalia* type. The small additional slits occurring in some forms, such as *M. acuta*, are cases of partial reversion to the multifissate ancestral form which gave rise to the family.

Two species of *Mopalia* were placed by Carpenter in *Placiphorella* on account of their possessing sutural pores. Dall justly remarks that they differ from the true Placiphorellas, and he proposes *Osteochiton* as a section of that group for their reception. It is my belief that these species have no near alliance with *Placiphorella*, but that they are merely modified Mopaliæ. The gathering of a few hairs or spicules into a pore at the sutures is no uncommon occurrence, and in some cases (such as *Ceratozona*) it is not constant even as a specific character. In *Mopalia* this modification will probably be found to occur in all the forms in which the girdle is nearly naked. In a small form of *M. muscosa* from Bolinas Bay the pores are sometimes present at all of the sutures, and sometimes at only two or three on one side, entirely absent on the other side. Sometimes they bear each a large hair, sometimes none. It is therefore obvious that we can make no disposition of *Osteochiton* except to consider it an absolute synonym of *Mopalia*.

M. MUSCOSA Gould. Pl. 63, figs. 46–48 (typical), figs. 49–63 (varr).

Shell oval, elevated or depressed, the dorsal ridge more or less angular. Valves strong. Surface lusterless, finely sculptured with wavy, crenulated logitudinal riblets, often more or less obsolete. Color generally dull brown, blackish-olive or grayish, but sometimes bright orange, scarlet or vivid green.

Median valves hardly beaked, the lateral areas slightly raised, granose, limited by a raised granose riblet. Central areas having close fine longitudinal riblets, with crenulated or latticed interstices, the riblets finer and converging on the ridge of the last 6 valves, diverging on the second valve, or strongly diverging on the ridge of all valves, like a series of superimposed v's. Anterior valves having about 10 narrow radiating granose riblets, the intervals granose. Tail valve depressed with posterior mucro, the posterior slope very short, emarginate behind.

Interior bluish-green, stained with lilac on the central callus. Anterior valve having 8, median 1 short slit, the teeth long, deeply striated outside and thickened or propped outside at the sides of the slits. Posterior valve having a rounded sinus behind, with one oblique slit on each side, the plate roughened outside near the slits. Sutural plates broad, *the sinus extremely shallow and small.*

Girdle rather narrow, densely covered with round, curved or curled hairs. Gill row as long as the foot (pl. 64, fig. 74).

Length 52, breadth 38 mill.

Length 25–60, breadth 15–40 mill.; divergence 120°–140°.

Shumagin Is. (rare) *to San Diego, California,* between tide marks and at lowest water.

Ch. muscosus GLD., Proc. Bost. Soc. N. H. ii, p. 145, July, 1846; Exped. Moll., p. 313, f. 436; Otia, p. 6.—*Chiton ciliatus* REEVE Conch. Icon., t. 19, f. 124.—*Mopalia ciliata* H. & A. AD. Gen. Rec. Moll., i, p. 478.—DALL, Proc. U. S. Nat. Mus., 1878, p. 303 (synonymy and variation); p. 298, f. 35, 35a (dentition). NOT *Ch. ciliatus* Sowerby!—*Chiton setosus* SOWB. in Beechey's Voy. 'Blossom' p. 150, t. 41, f. 17 (not *C. setosus* Sowb. 1832).—*Ch. collei* REEVE, Conch. Icon., t. 21, f. 136 (1847).—*Ch. wosnessenskii* MIDD. Mal. Ross. i, p. 101 (part of diagnosis).—*Chiton armatus* NUTT., JAY'S Catalogue, 1839, no. 2678 (not described); *Ch. arenatus* NUTT., in Mus. Acad. Nat. Sci. Philadelphia.—*C. ornatus* NUTT. *MS.* CPR., P. Z. S. 1855, p. 232.—and *C. consimilis* NUTTALL, *MS.* in Brit. Mus.

In its typical state (pl. 63, fig. 46), this species may be known by the strong though variable sculpture, dull brown or blackish-olive color, the small sinus, the girdle being thickly set with round hairs varying from strong bristles to soft hairs. A variation in color is seen in some southern specimens (Tomales Bay) which are orange or scarlet (pl. 63, fig. 48), or yellowish maculated with orange and vermilion. Others from the same locality are vivid blue-green or green (pl. 63, fig. 47).

In his work on the Chitons of Alaska, Dr. W. H. Dall discusses the synonymy and variation of this species, concluding that *M. lignosa* Gld. should be regarded as an extreme form, connected by intermediate examples with the typical *muscosa*. He writes as follows: "This species can be distinguished from all varieties of *wossnessenskii* by its blackish and proportionately much narrower girdle, and by a sort of prolongation of the external layer of the shell forward under the apex of the next anterior valve in the median line, forming a sort of anterior false apex, which is hidden until the valves are separated. In *wossnessenskii* this part is squared off, the girdle is yellowish (when alive), and the valves are much less transverse. It will be surprising if those who have only observed these animals by a few dry specimens in collections are willing to accept the synonymy above given, I confess that not long since I would have been unwilling to believe that the rough, bristly, typical *muscosa* and the dark, smooth *hindsii* could be properly combined under one name with each other or with the finely reticulated and painted *lignosa;* but the study of a large multitude of specimens has convinced me no arbitrary line can be drawn anywhere in a fully representative series, beginning with coarsest *ciliata* [*muscosa*] and ending with a practically smooth *hindsii*. The characters of girdle, sculpture and form are not only variable in themselves, but are found variably combined, except that it is rarer to find coarsest sculpture with a downy than with a bristly girdle. However, even this occurs. On the other hand, out of such a series a dozen forms might be selected which, if only the characters were constant, every one would acknowledge as good species."

Var. HINDSII (Sowb.) Reeve. Pl. 62, figs. 99, 100; pl. 63, fig. 57.

Shell elongated and *much depressed*, (the angle of divergence about 140°), the *girdle encroaching at the sutures*. External color a light or dark shade of olive. Surface smoother than in typical

muscosa; the granose-corrugation being more or less zig-zag or criss-cross on the central areas, obliquely corrugated-granose on the lateral areas. *Interior white, with short crimson rays under the beaks;* tail sinus visible outside. Girdle with few and short hairs.

Chiton hindsii (Sowb. in Mus. Cuming) REEVE, Conch. Icon., t. 12, f. 67*a*, *b* (1847).—*Mopalia hindsii* GRAY, P. Z. S. 1847, pp. 69, 169.—H. & A. AD., Genera Rec. Moll. i, p. 478, iii, t. 54, f. 7.—*Mopalia ciliata var. hindsii* DALL, Proc. U. S. Nat. Mus. 1878, p. 304.

The specimens described are from San Francisco Bay. The tegmentum or outer layer of the valves projects forward somewhat at the sinus, as in typical *muscosa*; but this can be seen only in the detached valves.

Var. PORIFERA Pilsbry. Pl. 62, figs. 93, 94.

Another form of *muscosa*, which if constant in its peculiar features would make an excellent new species of the section *Osteochiton*, is before me from Bolinas Bay. It is perhaps deserving of a varietal name. The shell is rather small, thin and high, but not to as great an extent as *M. acuta*. It is sculptured as in *M. hindsii*, but the diagonal and sutural ribs are more prominent, and sculptured with strong, transverse beads exactly as in *M. imporcata*, the suture being dentated by them. Color of valves olivaceous, clouded obscurely with smoky, and having a black stripe each side of the dorsal lighter stripe. The posterior valve has a depressed mucro near the posterior margin, which is very slightly waved inward. Girdle firm and leathery, minutely and evenly papillose all over, blackish with spots of orange; having a small pit or pore at each suture, with a series of pores alternating with these a little outside of the middle of the girdle (pl. 62, fig. 93). Sometimes some of the sutural pores bear large hairs, curling outward; and sometimes some or many of the pores are completely absent.

Length 23, breadth 13½ mill.; divergence 105–115°.

The interior is a deep blue-green, or gray-blue with a purple-pink blush.

Var. ACUTA Carpenter. Pl. 64, figs. 75–81.

Shell rather small, strongly elevated, the dorsal ridge acute; valves thin; sculpture minute and delicate, varying between a minute granulation and a fine pitting; the sutures delicately dentic-

ulate; diagonal riblets obsolete or delicately raised. Color olivaceous obscurely mottled with dusky, the tail valve having a light ray behind.

Interior blue-green. Tail valve slightly waved upward in the middle behind, and *having either a simple narrow caudal slit, or a slit with a small tooth set in its apex.* Lateral slits of the tail valve generally double on one side. Girdle narrow, sparsely hairy.

Length 22½, breadth 12½ mill.; divergence 105° (Carpenter's type).

Length 22, breadth 13 mill.; divergence 105° (San Diego spec.).

Length 23, breadth 15 mill.; divergence 98° (Sta. Barbara spec).

Santa Barbara (Canfield, Gabb.); *San Diego* (Hemphill).

Chiton acutus Cpr., P. Z. S. 1855, p. 232.—*Mopalia acuta* Cpr., Brit. Asso. Rep. 1863, p. 648.—*Mopalia plumosa* and *M.* (*? var.*) *fissa* Cpr., *MS.* (? Not *Ch. plumosus* Gld).

The comparative tenuity of the highly angled valves, their delicate sculpturing over the whole surface, the fine denticulation of the sutures and the narrow, often toothed caudal sinus, all give an aspect of individuality to this form, and cause me to rank it with *hindsii* and *lignosa* as a well-differentiated subspecies.

Carpenter, working from very few specimens, made three species of the forms of this. The occasional bi-slitting of the tail plate on one side is found also in some specimens of the elevated variety of *lignosa* from Olympia, Wash. It seems to me to be a very variable and trifling character. The caudal sinus seems to be indifferently narrowly slit or with a little denticle in the apex of the slit, and this little denticle also occurs sometimes in *M. lignosa.* The posterior valve has a narrow light triangle behind in all the specimens I have seen.

I have no hesitation in pronouncing *plumosa* and *fissa* absolute synonyms of *acuta,* but give here Carpenter's descriptions.

M. plumosa Carpenter. (Pl. 64, figs. 80, 81.) Shell oval, regular, thin, elevated, the dorsal ridge acute, mucro behind the middle, depressed. Valves subquadrate, slightly beaked behind, hardly so in front. Olivaceous-ashen maculated with darker; central areas (with the scarcely defined jugal tracts) reticulated-porous, being sculptured with interlacing riblets forming quincuncially arranged impressed pits. Lateral areas defined but hardly elevated, sculp-

tured with plume-like radii, granose at the sutures, the diagonal ribs and the radiating riblets of the head-valve; the grains elongated, subspinose, *elegantly serrating the sutures.*

Interior pale blue. Tail valve having the posterior sinus hardly indicated externally, *small, with a minute tooth set in at the apex; at one side it has* 2, *at the other* 3 *slits;* slit-rays inconspicuous. Central valves having 1, anterior valve 8 slits, the slit-rays conspicuous; teeth acute, small. Eaves small, very spongy. Sinus small, deep, flat, the sutural plates separated.

Girdle thin, narrow, smooth, sparsely and irregularly beset with subtranslucent, larger and smaller tubular bristles.

Length 16¼, width 11 mill.; divergence 112°.

Habitat unknown.

The above description, from Carpenter's *MS.*, was drawn from a single specimen in the collection of Dr. Wesley Newcomb (now of Cornell College). The figures 80, 81 represent the same specimen.

Var. *fissa* Cpr. Sculpture between that of *M. acuta* and *M. plumosa;* the granules at the suture and diagonal rib hardly claw-shaped; color and form also intermediate. Interior: posterior valve having two slits on one side, one on the other, the median caudal sinus minute, acutely slit; otherwise normal. Girdle smooth with sparse, small spines.

Length 15, breath 10 mill.; divergence 115°.

This form was described by Carpenter from a single specimen from Monterey. It differs from *acuta* and *plumosa* in lacking the "key-stone" like structure of the caudal sinus; but the series examined by me proves that this character has no constancy.

Subspecies M. LIGNOSA Gould. Pl. 63, figs. 58, 59 (typical); 60, 61, 62, 63.

Shell oval, elevated, carinated or angular at the dorsal ridge, the side-slopes straight. Surface lusterless, apparently smooth; grayish, greenish or bluish with radiating streaks, lines and flammules of brown or purple-brown.

Under a lens the lateral areas appear nearly smooth; the central areas being closely and finely pitted all over. Girdle narrow, sparsely hairy.

Interior white and light blue. Length 60, breadth 35 mill.; divergence 120°.

Vancouver I. to Monterey, California.

Chiton lignosus Gld., Proc. Boston Soc. N. H. ii, p. 142, (July, 1846); Otia Conch. p. 3; U. S. Expl. Exped., p. 330, f. 424.—*Chætopleura lignosa* Gld., Otia, p. 248.—*Mopalia lignosa* Cpr., Rep. Br. Asso. 1863, p. 648.—*Chiton merckii* Midd., Bull. Imp. Acad. Sci. St. Pétersb. vi, p. 20, 1846; Mal. Ross., i, p. 115, t. 11, f. 5–6.—*Ch. eschscholtzii* Midd., Bull. *l. c.* p. 118, Mal. Ross., i, p. 114, t. 11, f. 4 (young shell).—*Chiton montereyensis* Cpr., P. Z. S. 1855, p. 231.—*Chiton vespertinus* Gld., U. S. Expl. Exped. Moll. p. 323, t. 426, 426a (1852).—*Chætopleura vespertina* Gld., Otia, p. 230, 242.—*Mopalia vespertina* H. & A. Ad., Gen. Rec. Moll. i, p. 479.—*Mopalia simpsoni* Gray, P. Z. S. 1847, p. 69; H. & A. Ad., Gen. p. 479; and Brit. Mus. Coll. (name only; never described. Type examined by Cpr).—*Mopalia ciliata subsp. lignosa* Gld., Dall, Proc. U. S. Nat. Mus. 1878, p. 304.

Typically the *M. lignosa* is extremely unlike *M. muscosa*, but I am compelled to agree with Dall that there exist specimens completely uniting the two. A number of published names are above added to the long list of synonyms given by Dall (*l. c.*); and *Ch. californicus* (Nutt.) Reeve, which Dall includes, is removed, as it belongs to the genus *Nuttallina*.

The typical *lignosa* (figs. 58, 59) is exactly equal to *merckii*, to *montereyensis*, and to the unpublished *insignis* Newc. (fig. 63). It differs from the following form in the even puncturing of the surface (obsolete on lateral areas), the peculiar painting, and white interior.

The principal mutations of this type of *Mopalia* are (1). Toward still smoother forms entirely lacking pitted or reticulated sculpture, having only a few subobsolete longitudinal wrinkles on the ridge, the painting in concentric streaks (following growth marks) on each valve. This is shown in figs. 60, 61, of pl. 63, the specimen illustrated being from Olympia, Washington. The *C. vespertinus* of Gould is closely connected with this form, but is represented as typically much pitted (fig. 62). It is stained with crimson within.

(2). Form *elevata* (pl. 64, figs. 82, 83). More elevated, acutely carinated, more or less pitted superficially, and either painted with the pattern of typical *lignos* on a white, creamy or green ground, or having concentric zig-zag blackish streaks (fig. 82). Divergence about 90°. The interior is bright green or blue.

(3). Forms connecting with *M. muscosa var. hindsii*, having the color pattern of *lignosa*, but the sculpture intermediate in char-

acter or quite like that of *hindsii*.

M. MIDDENDORFFII Schrenck. Pl. 62, figs. 88, 89, 90, 91, 92.

Shell elevated. Coloration: a broad whitish area along the middle, with transverse flammules and lines of red-brown on the ridge; at the sides concentrically and longitudinally painted with red-brown and whitish.

Median valves having the apex indistinct, the lateral areas distinct. Entire surface radially closely pitted, the pits very distinct over the whole of the central areas, and in the middle of the lateral areas, but obsolete on the front and back edges of the latter. Anterior valve having 8 radiating riblets. Posterior valve slightly emarginate behind.

Interior roseate in the middle; lateral slits distinct; sinus shallow. Anterior valve having 8, central 1, posterior two slits.

Girdle of moderate width, brown-red, setose, the setæ irregularly and sparsely scattered, whitish, and about 3 mill. in length. Branchiæ median, with about 36 branchial lamellæ.

Length 14 mill.; divergence about 115°.

Bay of Castries in 25 ft.

Chiton middendorffii SCHRENCK, Bull. de l'Acad. des Sci. St. Pétersb. iv, p. 408; Mel. Biol. iv, p. 89; Reisen und Forsch. in Amur-Lande, ii, Zool., p. 278, t. 12, f. 1–8 (1867).

A single specimen of this species was dredged by Schrenck, from whose account the above description is compiled. The sculpture strongly reminds one of some forms of *Mopalia lignosa* Gld., but the coloring differs markedly, and the habitats of the two are widely sundered.

M. IMPORCATA Carpenter. Pl. 62, fig. 98.

Shell small, oblong, strongly elevated and acutely carinated, the side-slopes straight. *Buff-white, slightly stained with rust-brown.*

The median valves are acute at the umbo, but there is no projecting beak; lateral areas bounded by a *strongly elevated, narrow, crenulated diagonal rib,* and having *a wider rib at the sutural margin, also crenulated,* thus denticulating the suture; the space between the two lateral ribs being finely corrugated-granose. Central areas sculptured with strong, curved longitudinal ribs, which converge forward somewhat, toward the median keel; the intervals between these ribs being closely and finely latticed across by

threads radiating from the beaks. Anterior valve having 8 strong, narrow, raised ribs, with one wider rib at each sutural edge. Posterior valve depressed, *the mucro situated at the posterior end.*

Interior white; sinus very small and shallow. Anterior valve having 8, median 1 slit; teeth but little thickened along the slits. Posterior valve having a rather wide moderately deep rounded tail sinus, and a single slit on each side.

Girdle leathery, dusty, with a hair-pore at each suture, and some scattered or alternating hairs.

Length 10, breadth 6 mill.; divergence 95°.

Puget Sound (Kennerley); *Sta. Barbara* (Cooper).

?Mopalia imporcata CPR., Proc. Acad. Nat. Sci. Phila., 1865, p. 59.—*Placiphorella imporcata* CPR., in Dall, Proc. U. S. Nat. Mus. 1878, p. 306.—*Osteochiton imporcatus* DALL, l. c. 1886, p. 211.

This species closely resembles *M. sinuata* in size and sculpture. The two species differ in the following details: (*a*) *M. imporcata* is unicolored, while the other is elegantly marbled with blue and tawny; (*b*) *imporcata* has the sutural ribs more developed and very distinctly serrated, whilst in *sinuata* the serration is hardly apparent; (*c*) *imporcata* has the longitudinal riblets of the central areas larger and the radiating threads which lattice their interstices much smaller and much closer; and finally, (*d*) the tail valve in *imporcata* has an entirely posterior mucro, and a much shallower posterior sinus.

The girdles are the same in both species, being leathery, generally "dusty" in appearance in dried specimens, although scales are quite absent.

This species might be considered a subspecies of *M. muscosa* were it not that it is smaller and more highly angled, of a uniform light color, and has the mucro farther to the rear. The girdle-pores at the sutures, and the entire sculpture are exactly like the pore-bearing variety of *muscosa* which I have above described from Bolinas Bay. It is very likely that the intervening links required to complete this chain of forms will be found.

The description and figures are drawn from Carpenter's type specimen, now in the U. S. National Museum.

The length is estimated in this and the following species, as the specimens are somewhat curled.

M. SINUATA Carpenter. Pl. 62, figs. 95, 96, 97.

Shell oblong, elevated and strongly carinated, the side-slopes straight. Color whitish, *clouded with delicate blue-green and maculated with rich tawny brown.*

Median valves hardly beaked, the lateral areas not raised, but strongly defined by an elevated diagonal rib; sculptured with two oblique series of fine riblets forming a latticed pattern. Central areas having a series of longitudinal curved riblets converging toward the median keel, crossed by curved radiating threads a little finer and less prominent (fig. 97). Anterior valve having 8 (not counting the posterior sutural borders) strong radiating ribs narrower than the latticed intervals. Posterior valve depressed, *the mucro being at the posterior third.*

Interior bluish-white. Sinus very small and narrow. Anterior valve having 8 slits, median 1 slit; teeth thickened outside at the edges of the slits. *Posterior valve* (fig. 96) *having a deep rounded median sinus* behind (*which is continued upward in a superficial excavation to the mucro*), and a single slit on each side.

Girdle rather narrow, leathery, "dusty" bearing a few hairs, with a rounded pore at each suture (fig. 95).

Length 11½, breadth 7 mill.; divergence 105°.

Puget Sound (Kennerley); *San Francisco Bay* (Newcomb).

? Mopalia sinuata CPR., Proc. Acad. Nat. Sci. Phila., 1865, p. 59. —*Placiphorella sinuata* CPR., *MS.* and in DALL, Proc. U. S. Nat. Mus. 1878, p. 303, 306.—*Osteochiton sinuatus* DALL, *l. c.* 1886, p. 211.

This little species has the form and sculpture of the true Mopalias, but it differs from them in the posssesion of a bristle or hair-bearing pore at each of the sutures, the girdle elsewhere bearing sparsely scattered hairs on the leathery, minutely roughened surface. It resembles *M. imporcata* but is sufficiently different in sculpture.

My description and figures are from Carpenter's type specimen, now in the Smithsonian collection.

M. CILIATA Sowerby. Pl. 64, figs. 64–73.

Shell oblong, rather depressed, the dorsal ridge carinated (sometimes rounded), side-slopes straight or somewhat convex. Surface lusterless, finely sculptured, variously colored, usually either (1, typical coloring) verdigris green maculated with black or black-brown, the girdle yellow (fig. 65) or (2) maculated with maroon and sometimes touched with rich chestnut on the ridge, or having

some valves or parts of valves vivid scarlet (fig. 64), or scarlet mixed with olive and snow-white, or entirely white; or (3) light olive-buff with brownish girdle (fig. 67).

Valves somewhat beaked, the lateral areas bounded by a riblet, rather coarsely granulated, with larger granules along the posterior margin. Central areas sculptured with longitudinal, curving riblets somewhat granulated, much closer and finer on the dorsal ridge. Anterior valve having granose narrow radii, the intervals granulated. Posterior valve small, with posterior mucro, broadly emarginate or waved at the hinder margin.

Interior bluish-white or light blue-green. *Sinus broad and rather rounded, spongy or roughened.* Sutural plates arcuate. Anterior valve having 8 slits, median valves 1 slit. *Posterior valve having a broad deep, rounded caudal sinus,* and a single slit on each side.

Girdle wide, yellow or brown, generally notched behind, more or less sparsely *clothed with curling strap-like brown hairs, which bear near their bases a bunch of minute, white, acute spines.* (fig. 66; the line below is 1 mill. long).

Length 46–50, breadth 25 mill.; divergence 125°.

Unalashka, Aleutian Is. (small and rare) *to Sitka, and southeastward to Monterey, California;* low water to 20 fms. on stones and shells.

Chiton ciliatus SOWERBY, Ann. and Mag. Nat. Hist. 1840, p. 289; Conch Illustr., f. 79 (1840). Not *Chiton ciliatus* Reeve, nor *Mopalia ciliata* Dall.—*Chiton wosnessenskii* MIDD. Bull Acad. Imp. Sci. St. Pétersb. iv, p. 119, 1847.—*Chiton* (*Hamachiton, Platysemus*) *wosnessenskii* MIDD., Mal. Ross., i, p. 34, 101, t. 11, f. 1–2.—*Mopalia kennerleyi* CPR., Suppl. Rep. Brit. Asso. Adv. Sci. 1863, p. 648; Proc. Acad. Nat. Sci. Phila., 1865, p. 59.—*M.* (*kennerleyi var.*) *Swannii* CPR., Ann. Mag. N. H. xiv, p. 426, 1864; Suppl. Rep. B. A. p. 648.—*Mopalia grayi* CPR., *l. c.* p. 603 (name only).—*Mopalia wossnessenskii* Midd., DALL, Proc. U. S. Nat. Mus. 1878, p. 305 (1879).

This species is distinguised from *M. muscosa* and its immediate allies by its color; by the lack of that narrow anterior projection of the outer layer at the sinus, so conspicuous in the detached valves of the typical *muscosa;* by the encroachment of the wide girdle at the sutures, the deeper caudal wave of the tail valve, and *especially by the broad, rounded sinus between the sutural plates.*

This last seems to be a constant character, and the peculiarity of the tail valve noticed above is also reliable; but the encroachment of the girdle at the sutures is seen also in *M. hindsii*; the lack of an anterior projection or "false beak" is characteristic of many varieties of *muscosa*, such as the elevated var. of *lignosa* found at Olympia, Washington, and the var. *acuta* Cpr. from southern California. The girdle covering presents a peculiarity not hitherto noticed; near the base of each of the curled brown hairs, there is a bunch of tiny white thorns or spines. These are also numerous at the edge of the girdle, which is seen slightly rolled upward in fig. 66.

Dr. Carpenter studied the specimens of "*C. ciliatus*" in Cuming's collection, and found them to be genuine *muscosus*; and therefore Dall in his report on the Chitons of Alaska, as well as other American writers, accepted the name *ciliata* in place of *muscosa*. Unfortunately, the Cumingian specimens are not the true *ciliatus* of Sowerby, although described and figured as such by Reeve. The original *C. ciliatus* is identical with the small, green black-mottled form of "*wosnessenskii*" found at Monterey, etc.

An excessively rare monstrosity is shown in fig. 67, representing a seven-valved specimen, in which the reduced number is not due to injury or coalescence of valves, each valve being completely normal both outside and within. This figure, and figs. 64, 65, are drawn from Monterey Bay specimens. The sculpture (fig. 68) is stronger and sharper in typical *ciliata* than in the var. *wosnessenskii* (fig. 72).

Var. WOSNESSENSKII Midd. Pl. 64, figs. 69–73.

Shell elongated, *the back roundly arched* not carinated; dull colored, varying from light olive or green to drab, generally with blackish patches on each side of the middle, and more or less mottled throughout with dusky. *Sculpture much fainter than in typical ciliata.* Girdle apparently lacking the white spicules described above.

Sitka (Wosnessenski, figs. 69–71); *Olympia, Washington* (Hemphill, figs. 72, 73).

This seems to be recognizably distinct from the typical *ciliata* from Monterey, etc. American authors have hitherto given Wosnessenski an *s* too many.

Genus XXX. PLACIPHORELLA Carpenter.

Placiphorella CPR., *MS.* in Dall, Proc. U. S. Nat. Mus. 1878, p. 303, 306. Type *P. velata* Cpr.

Valves very broad and short, the middle ones much broader than those toward the ends; head valve narrowly crescentic, tail valve still smaller, with posterior mucro. Sinus small; insertion-plates short and thick, the teeth lobed or rugose. Slits 8 or more in the anterior, 1 in the median, 2 in the posterior valve, which has also a shallow posterior sinus. Eaves spongy. Girdle widest, often very wide, in front, bearing sparsely scattered, *scaled* hairs.

This genus differs from *Mopalia* in the rotund contour of the valves taken together, and their extreme shortness individually, as if the shell had been crowded together from the ends. The slits are practically as in *Mopalia*, being normally (or at least originally) 8 in the head valve; but this number is frequently increased by the splitting of some teeth. The mantle-edge is produced in front and fringed with long fleshy finger-like processes. The larger hairs of the girdle are extremely peculiar, being covered with imbricating scales like a snake skin, on a corneous core. Nothing of the sort has been found in any other group of Chitons.

Carpenter originally intended this genus to include forms having hair-pores at the sutures, regardless of the other characters of valves and girdle; but the presence of pores is not, in *Placiphorella* and *Mopalia*, even a constant specific character.

The species are separated by rather slight characters and owing to the rarity of specimens in collections, we are not yet prepared to say to what extent the characters will hold good.

P. VELATA Carpenter, n. sp. Pl. 66, figs. 6–12.

Shell roundly oval, broad, rather depressed, quite obtusely angled. Surface lusterless. Light colored along the middle, mainly olivaceous on the sides, especially the lateral areas; the central areas variously streaked longitudinally with buff, blue, chestnut and pink.

Median valves not beaked, marked by growth lines; the lateral areas somewhat raised, having a rounded wide diagonal rib and another at the sutural margin, the space between them more or less excavated. *Central areas having a "false beak" or narrow projection forward at the dorsal ridge* (only visible when the valves are separated.) Anterior valve crescent shaped, sculptured with light concentric growth-lines only. Posterior valve small, slightly waved inward behind, *the mucro far backward, recurved and elevated, the slope in front of it concave in profile,* unless the mucro is eroded.

Interior white, slightly blue tinted. *Sinus in valves* i *to* vi *represented by a very shallow wave, the sutural plates continuous, being connected by a plate which fills the sinus like a key-stone;* in valves vii to viii the sinus is deeper and more distinctly angular. Anterior valve having 8 slits, the teeth obtuse, short, often bilobed or conspicuously rugose. Central valves having 1 slit, teeth wedge-shaped, thicker at the edges of the slit. Posterior valve having a very heavy callus supporting the short, rugose insertion-plate, which is interrupted posteriorly by a broad, shallow sinus, and has 1 slit on each side (occasionally two on one side).

Girdle very broad in front, reddish, fading to yellow toward the outer edge, irregularly and sparsely beset with scaly hairs (fig. 13), of which one or two are generally to be seen in each suture; a close fringe of short (broken) hairs adorns the girdle-edge.

Length 50, breadth 38 mill.; divergence 135°.

Length 30, breadth 24 mill.; divergence 130°.

Humboldt Bay (Newcomb) *and Monterey Bay* (Canfield, Hemphill, et. al.), *California; Todos Santos Bay, Lower California* (Hemphill).

Placiphorella velata Cpr., *MS.*—Dall, Proc. U. S. Nat. Mus. 1878, p. 303, 307 (description of animal); p. 298, t. 2, f. 36, *a* (dentition).

This species is distinguished from the the next by its differently formed posterior valve, by the connection of the sutural plates across the sinus, and the anterior projection of the tegmentum at the sinus. The largest specimens I have seen were collected by Hemphill at Todos Santos Bay.

Fig. 12 represents the insertion-plates of an intermediate valve seen from their summits, showing the subtriangular form of the posterior insertion-tooth, the non-thickened edges of the slit, etc.

P. stimpsonii Gould. Pl. 62, figs. 84, 85, 86, 87.

Shell broadly oval, depressed, subangular, with straight side-slopes. Color whitish along the middle, the sides mottled and streaked with greenish-yellow, olive and blue, the colors so blended as to give a general effect of dark olivaceous.

Valves not beaked, sculptured with unequal growth-lines. Lateral areas having a moderately prominent diagonal rib, with an inconspicuous wider, lower, sutural rib, the space between excavated. Anterior valve narrowly crescentic, concentrically striated, but

lacking all radiating sculpture. Posterior valve (figs. 84, 85) depressed, the mucro near the posterior margin, which is slightly and rather broadly waved inward.

Interior delicately blue-green tinted. Sinus a rather shallow rounded wave in the earlier valves, becoming deeper, narrower and angular in the eighth valve. Anterior valve having 8 slits, median valves having 1 slit on each side; the eaves narrow, tenaciously adhering to the girdle.

Posterior valve small, its greatest width, including insertion and sutural-plates, measuring hardly more than one-half the width of the widest median valves; the short posterior insertion-plate rising from a very heavy callous rim; having one oblique slit on each side, and an almost imperceptible wave where the posterior sinus should be.

Girdle rather narrow, brown, leathery, sparsely beset with spinules (the stumps only remaining in the specimen before me), of which there is one at each suture and a marginal fringe.

Length 17, breadth 12½ mill.; divergence 140°.

Hakodadi Bay, Japan (Stimpson), in 25 fms.

Chiton (*Mopalia*) *stimpsoni* GOULD, Proc. Bost. Soc. N. Hist., vii, p. 165 (1859); Otia Conch. p. 118.—*Conf.* DALL, U. S. Nat. Mus. 1886, p. 210.

The above description is from the type in the U. S. National Museum (no. 1646). It will be seen that the species differs from *P. borealis* in the smooth, not radially sculptured anterior valve, in the strongly calloused interior of the posterior valve, its shallower tail sinus, etc. The *P. velata* Cpr. of California has the valves very similar to this species in form; both differing widely from *P. borealis* in the solid, not spongy, sinus, partly filled by a short lamina connecting the sutural plates; in the more calloused interior of the posterior valve and its smaller size; the non-radiated anterior valve, etc.

Carpenter has given the following notes in his *MS.* on a fine specimen from Japan, in the Jeffreys collection. "As curled up and dried it measures, length 23, breadth 21 mill.; divergence 120°. It is olivaceous and orange-ash variegated. Anterior valve smooth. Posterior valve having the mucro raised, at the posterior third, the sinus continued upward to it outside. Central valves with two obsolete but swollen ribs, one sutural, the other diagonal, with a broad depression between them. The girdle is very much shrivelled

and the head expansion doubled up, but the hairs are very well preserved. Over the whole of the marginal part are very short crowded deciduous whitish hairs. Over the greater portion of the surface are scattered distant large tubular, horny hairs, which seem to arise deep in the girdle. These hairs are not scaly as in *P. blainvillii*, but present when perfect the aspect of *Aspergillum vaginiferum* in miniature. I cannot say with confidence that all the hairs are so sculptured, for some which look perfect do not show it."

A sketch made by Dr. Carpenter from a hair of this specimen is copied on pl. 62, fig. 86. The hairs on Gould's type are broken to very short stumps, not long enough to show their structure.

P. BOREALIS Pilsbry, n. sp. Pl. 66, figs. 14, 15, 16, 17.

Shell similar in general characters to *P. velata*. Brown at the sides, light along the middle. Surface dull, showing growth-lines.

Valves not beaked, having a slight forward bend in the middle at the sinus, but not "false beaked" there as *P. velata* is. Lateral areas more strongly 2 ribbed. *Anterior valve sculptured with numerous very low, wide radiating riblets.* Posterior valve having the mucro near the posterior margin, depressed, the slope in front of it rising, convex rather than concave; posterior margin waved inward.

Interior light blue-green. *Sutural plates separated in all the valves by an angular, spongy sinus.* Anterior valve having 11 slits, the teeth unequal, lobed or roughened. Median valves having one slit, *the teeth being peculiarly curved outward* at its edges. Posterior valve much less callous inside than that of *P. velata*, the insertion-plate uneven, roughened, but having a single well developed slit on each side; the median tail-notch deep and wide. Eaves very spongy. Girdle unknown to me.

Breadth of anterior valve 16, length of front slope, including teeth 4½ mill.

Breadth of a median valve 22, length from sinus to beak 4½ mill.

Breadth of posterior valve 15, length direct from sinus to sinus 5 mill.

Divergence 135°. Measurements of breadth include the insertion-plates.

Bering Island, Bering Sea (Grebritzki).

Placiphorella stimpsoni DALL, (part), Proc. U. S. Nat. Mus. 1886

p. 210. Not of Gould.

This form is known to me by the valves of a single individual, no. 106,922 of the Smithsonian register. It differs from *P. velata* in the greater prominence of the lateral ribs, the curiously excurved teeth of the side insertion-plates (fig. 15), the less calloused interior of the posterior valve, and its very different form. Compare fig. 9 with fig. 16, the former representing the tail valve of *P. velata*, the latter that of *P. borealis*. Some other differences are indicated in the descriptions. In this specimen the slit on one side of the posterior valve is nearly obsolete.

P. BLAINVILLII Broderip. Pl. 66, figs. 26–32.

Shell ovate, very broad, depressed; variously clouded, streaked and maculated with rosaceous and olivaceous or red-brown, generally tessellated at the sutures.

Median valves hardly beaked. Jugal areas sometimes defined by an obsolete v-shaped sulcus. Central areas appearing a trifle and most minutely granulate under a lens, otherwise smooth and shining. Lateral areas slightly swollen, concentrically marked by ribs of growth; margins of valves rounded, the sutures not very deep except in young specimens. Posterior valve having the mucro posterior, almost terminal; the posterior sinus of the valve wide and shallow.

Interior: anterior valve having 8 slits, the teeth rather short and roughened or crenulated outside. Posterior valve having a single slit on each side. Median valves with 1 slit; the sutural-plates rather straight and narrow, sinus a shallow wave.

Girdle thin, very broadly expanded, in front, narrow and not sinuous behind. Surface having sparse, comparatively short hairs, which in drying become appressed on the girdle, each hair appearing scaly under the microscope, like a snake's skin (fig. 28). The hairs are not especially sutural in position, suture-pores being absent in adult examples; nor do hairs occur in bunches anywhere. Besides these scaly hairs, there are scattered chaffy hairlets (which in one specimen more contracted than the rest are gathered into little bunches.)

Length 50, breadth 36 mill.; divergence 147°.

Inner Lobos Island (*Lobos de Tierra*), *Peru*, on stone in 17 fms. (Cuming.)

Chiton blainvillii BROD., P. Z. S. 1832, p. 27.—SOWERBY, Conch.

Illustr., f. 6.—Reeve, Conch. Icon., t. 3, f. 13.—*Mopalia blainvillii* Gray, P. Z. S. 1847, p. 69.—*Mopalia blainvillei* Carpenter, *MS.* and in Dall, Proc. U. S. Nat. Mus. 1878, p. 303.—*Placiphorella blainvillii* Dall, *l. c.* 1886, p. 210, 211.

This large species is nearly allied to *P. velata* of California, but it differs in having the lateral areas simply somewhat swollen, and not excavated in the middle. The sinus between the sutural plates is a shallow wave, but it deepens on the two or three backward valves, as in the Californian species. The description given above is compiled from Carpenter's notes on the type specimens.

P. petasus Reeve. Pl. 66, fig. 25 (enlarged.)

Shell small, somewhat abbreviately ovate. Valves with a polished, slightly beaked triangular area in the center, roughly granulated on each side. Bright scarlet. Ligament very broad, especially in front, also bright scarlet, beset here and there with short hairs and bristles.

Length 1, breadth ⅞ inch. (*Rve.*)

Cape Rivers, Celebes (Belcher.)

Chiton petasus Reeve, P. Z. S. 1847, p. 25; Conch. Icon., t. 26, no. 114, fig. 112, (not 112 on plate of details, nor 114); July, 1847. Adams & Reeve, Zool. of the Voy. H. M. S. 'Samarang,' Moll., t. 15, f. 11.

Referred to this genus on account of the peculiar girdle. A single specimen was collected. The characters of the interior have not been made known.

Genus XXXI. PLAXIPHORA Gray, 1847.

Plaxiphora Gray, P. Z. S. 1847, pp. 65, 68, 169.—Shuttlew., Bern. Mittheil. 1853, p. 69.—H. & A. Adams, Gen. Rec. Moll. i, p. 481.—*Placiphora* Cpr., *MS.* and in Dall, Proc. U. S. Nat. Mus. 1881, p. 284.—*Placophora* Dall, Cat. Mar. Moll. S.-E. U. S., p. 174; not *Placophorus* Mulsant, 1873 (*Trochilidæ*).—*Euplaxiphora* Shuttlew., l. c., (proposed for *biramosus* and *petholatus*).—*Euplaciphora* Cpr., *l. c.*, (type *P. petholata*).—*Chætopleura* (part) Rochebrune, Miss. Sci. du Cap Horn, 1882–1883, vi, Zool., Polyplacophores, p. 135 (1889), not *Chætopleura* Shuttlew.!

Valves mostly exposed, all having insertion-plates developed, that of the anterior valve normally with 8 (sometimes 7–9) slits (except in the subgenus *Placophoropsis* which has many slits). Median valves 1 slit. Posterior valve having *the insertion-plate smooth,*

unslit, interrupted behind by a median, rounded sinus, which does not generally emarginate the tegmentum; mucro posterior. Girdle bearing simple bristles or hairs, scattered or gathered into pores or tufts at the sutures. Type *Chiton setiger* King.

This genus is most nearly allied to *Mopalia* and *Placiphorella*, from both of which it differs in the unslit insertion-plate of the tail valve. The peculiar girdle-bristles of *Placiphorella* are an additional character separating the genera.

In *Plaxiphora*, as in *Mopalia* and *Placiphorella*, the bristles of the girdle are indifferently scattered or gathered into sutural bunches. This character is of specific value only when strongly developed; and each of the three genera contain species which in occasional individuals develop pores, or species usually poriferous, but varying to poreless. This distinction, which Blainville, Gray and the Adams brothers considered fundamental, is therefore of comparatively trivial importance.

Plaxiphora is divisible into a number of minor groups, as follows:

Subgenus PLAXIPHORA (restricted.)

Slits of anterior valve normally 8 (sometimes 7 or 9 by coalescence or splitting), coresponding in position to external ribs; the teeth long outside. Girdle widest at the sides. Mantle not fringed in front of the head. Distribution, Southern extremities of the southern continents; living in the littoral zone.

This subgenus although rather homogeneous, may conveniently be divided into three sections, as follows:

Section I. *Plaxiphora*, restricted (=*Euplaciphora* Shuttl. not Cpr.). Valves exposed. Entire shell normal in form; posterior valve not greatly reduced in size or altered in form.

Section II. *Guildingia* Cpr. Valves partially immersed in the girdle, which encroaches at the sutures.

Section III. *Fremblya* H. Ad. Valves exposed. Shell short and broad; the posterior valve reduced to a narrow crescentic form, and seen to be strongly arched upward if viewed from behind.

Subgenus PLACOPHOROPSIS Pilsbry.

Slits of anterior valve numerous (about 20); teeth very short. Girdle widest and much dilated in front. Mantle produced into several long finger-like processes in front of the head. Distribution, Northwest Atlantic; living in deep water.

Subgenus PLACOPHOROPSIS Pilsbry, 1893 (n. s.-g.)

Shell short, obovate, the valves short and wide; having very short, almost obsolete insertion-plates, that of the anterior valve having many (about 20) shallow notches; posterior valve with callous ridges at the sides and a shallow rounded caudal sinus. Girdle enormously broadened in front, narrow behind.

This section is intermediate between *Placiphorella* and *Plaxiphora*, differing from both and from and all *Mopaliidæ*, in the multiplication of anterior slits, although some specimens of *Placiphorella* show the same tendency. It must be understood that although in many groups of Chitons, such as all *Ischnochitoninæ* and *Chitoninæ*, the number of anterior slits is a character of merely specific importance, the case is far otherwise in those groups in which the slits correspond in number and position with external ribs, such as *Nuttallina* and its allies, and the *Mopaliidæ*, *Acanthochitidæ*, etc. In these groups the number of slits in the anterior insertion-plate is a highly constant generic character, apparent exceptions being generally readily traceable to the splitting of one or more primary teeth.

Besides the character just discussed, *Placophoropsis* resembles *Placophorella* in the form of the girdle; but it differs in lacking Mopaloid slits in the posterior insertion plates. Placophoropsis resembles *Plaxiphora* in the non-slit posterior insertion-plate, but it differs in the obsolescence and multiple slitting of the anterior insertion plate, and in the anterior dilation of the girdle.

The obsolescence or shortness of the insertion-plates in this form is evidently due to degeneration from disuse. Deep sea Chitons not being subjected to the constantly recurring impacts and stresses which affect littoral forms, have no need of elaborate structures for binding the valves in their places. Consequently the primitive forms, such as *Lepidopleurus*, have been able to survive unaltered under these conditions. In the case of *Placiphoropsis*, which is descended from littoral forms having long, well-developed insertion plates, especially in the anterior and median valves, the shortness of the plates is to be ascribed to the absence of the external stimuli which act constantly upon the littoral *Mopaliidæ*.

P. ATLANTICA Verrill & Smith. Pl. 66, figs. 18–24; pl. 65, figs, 73, 74, 75.

Shell *obovate, wider in front, tapering toward the small posterior valve, which is only about half as wide as the anterior valve.* Rather

depressed, roof-shaped, the dorsal ridge angular, side slopes slightly convex. Color pale brown, whitish along the middle and at the edge. *Girdle extremely wide in front*, narrow behind, dark brown in alcoholic specimens.

Median valves very wide and short, a trifle beaked in the middle. Lateral areas strongly elevated, the diagonal slope abrupt; slightly excavated in the middle, obsoletely granulated. Central areas having rather inconspicuous growth-lines and an obsolete or nearly effaced granulation. Anterior valve very short and broad, having many faint radiating riblets and obsoletely granulated throughout. Posterior valve small, with posterior, slightly elevated mucro, and elevated postero-lateral ribs.

Interior white. Sinus very narrow, square. Insertion-plates very short, almost subobsolete, that of the anterior valve wide, calloused, having about 20 irregular and excessively shallow notches (hardly slits), obsolete toward the ends; median valves with 1 slit. Posterior valve having a low wide callous ridge, slightly rugose, and in the middle interrupted by a shallow rounded sinus (pl. 65, figs. 73–75.)

Girdle "very broad anteriorly and narrow posteriorly. It increases gradually from the posterior end to a point opposite the fifth plate, where it suddenly expands into a broad round front, with the breadth one-third greater than the greatest breadth of the shell. It is thick, leathery and scabrous, everywhere closely covered with minute spinules; the lower surface anteriorly shows many radiating grooves (not distinct in the smaller examples); between these are rows of slightly raised small verrucæ, covered with small spinules. The inner edge, or mantle-border, is sharply defined, enclosing an elliptical area around the head and gills, with a well marked posterior sinus; its front edge is divided into about seven digitations, the anterior ones rather long, tapering, and tentacle-like but coriaceous and covered with fine spinules, like the rest of the marginal membrane. Cephalic hood large, broad-lunate; foot relatively small, ovate. Gills numerous (in the largest about sixteen on each side), extending nearly the whole length (more than two-thirds) of the foot, but reaching neither end of it."

Length of largest specimen (alcholic) 32, breadth 26 mill.; length of shell 21, breadth 18 mill. Divergence 130°.

N. lat. 40° 01′, *W. long.* 68° 54′, *in* 640 *fms., off Nantucket Island, and in N. lat.* 42° 15′ 25″, *W. long.* 65° 48′ 40″, *in* 122 *fms., off New*

England. (U. S. Fish Commission Steamer 'Albatross', 1883.)

Placophora (*Euplacophora*) *atlantica* V. & S., Amer. Journ. of Science xxiv, Nov., 1882, p. 365 (footnote); Trans. of the Connecticut Academy of Natural Sciences, vi, p. 206, t. 30, f. 1, 1*a*, 1*b*. (May, 1884).—*Placophora atlantica* V. & S., Dall, Bull. 37, U. S. Nat. Mus., p. 174, t. 45, f. 1*a*, *b*; t. 63, f. 102, 102*a* (reproduced from Verrill & Smith.)

A very peculiar species. The figures of the tail and head plates given by Verrill and copied on plate 66 are not very good, and I have therefore drawn others from one of the original specimens, on pl. 65.

The only specimen of this species which I have examined has a deep cleft in the posterior margin of the tegmentum of the tail valve, parallel to the lower border of the valve. Whether this is or is not abnormal must be decided by the examination of more material. It is well shown in fig. 74, of plate 65.

Subgenus Plaxiphora Gray.

Under this subgenus three sections, defined above, are placed.

Section *Plaxiphora* Gray.

This section as here restricted corresponds to Gray's original genus, except that he was ignorant of the fact that sutural pores or tufts are absent in some species. It is absolutely equivalent to Shuttleworth's section *Euplaxiphora*, but Carpenter restricted this last name to species of the *P. petholata* type, having no pores or tufts at the sutures. The mutability of this character has been discussed under *Mopalia;* therefore it is necessary in this place merely to state that the presence of pores at the sutures is not even a constant specific character in *Plaxiphora*, except when the tufts are strongly developed. There are several species in which the pores are visible in some specimens, but quite absent in others preserved in the same way.

The corrugated Plaxiphoras are in great need of revision; but the material now in museums is insufficient. Great latitude may be expected in the range of specific variation, as in the genus *Mopalia*.

Partial key to species of Plaxiphora.

a. Central areas unsculptured save for growth-lines.

b. Sutural pores or tufts distinctly developed; sinus shallow.

c. Anterior valve distinctly ribbed; lateral areas distinct, *setiger, biramosa.*

cc. Anterior valve smooth; lateral areas indistinct. Dark brown, banded with paler at the ridge, *simplex.*

bb. Sutural tufts or pores absent.

c. Lateral areas undefined, not sculptured.

d. Sinus deep, narrow, denticulate; brown, with a yellow-bordered dorsal band of chestnut, *wahlbergi.*

dd. Sinus wide, smooth; black, with a green-bordered dorsal black triangle, *glauca.*

cc. Lateral areas defined by a beaded rib, concentrically wrinkled.

d. Colors bright and variegated; size small, *carpenteri.*

aa. Central areas corrugated, at least at the sides, *Group of P. petholata.* *Group of P. terminalis.*

Group of P. setiger.

Shell smoothish; girdle with distinct sutural pore-bunches.

P. SETIGER King. Pl. 65, figs. 76, 77, 78, 79.

Shell elliptical, *low roof-shaped, the ridge carinated,* side-slopes straight. Surface lusterless, smooth except for delicate growth-lines. Color ashy-olive or bluish, with concentric dark streaks, and generally having unequal stripes radiating from the beak of each valve, these markings varying from indistinct to conspicuous.

The median valves are not beaked. Lateral areas not raised, but *clearly defined by a narrow, raised diagonal riblet, and perceptibly swollen or ribbed toward the posterior margin, giving the young a bicostate appearance; the two ribs being more or less nodose, especially in young specimens,* and toward the beaks in adults; and there are also a few extremely indistinct radiating riblets in the slightly excavated middle portion of the lateral areas. *Central areas smooth.* Anterior valve having about 8 narrow radiating riblets, becoming obsolete as they near the peripheral margin, but each ending in a

slight projection there; the intervals bearing some indistinct radii. Posterior valve depressed, the mucro inconspicuous and about at the posterior fourth; posterior area obsoletely radiately ribbed.

Interior light blue-green. *Sinus small and shallow.* Sutural plates low. Anterior valve having 8, central valves 1 slit; the slits short, continued in grooves to the eaves; teeth long, irregularly striated outside, thickest along the slits, sharp edged. Posterior valve having the insertion-plate long and stout at the sides, interrupted by a rounded sinus in the middle behind; its edge smooth, unslit. Eaves very narrow and very spongy.

Girdle rather wide, leathery, having at each suture a small pore bearing several long corneous bristles, and with one or two more or less irregular series of bristle-bearing pores on the surface of the girdle, and a more or less dense clothing of small soft hairs over its outer part.

Length 50, breadth 35 mill.; divergence 125–135°.

Chiton setiger KING, Zoological Journal v, p. 338 (1831).—SOWERBY, Conch. Illustr., f. 17; Zool. Beechey's Voy., pl. 40, f. 7 (bad).—REEVE, Conch. Icon. t. ix, f. 48a, t. xiv, f. 48c.—GOULD, U. S. Expl. Exped., Moll., p. 330, f. 425.—*Plaxiphora carmichaelis* GRAY, P. Z. S. 1847, p. 68, and subsequent writings, probably not *Chiton carmichaelis* GRAY, Spic. Zool. 1828.—*Plaxiphora carmichaelis* HADDON, Challenger Report, Polyplac., p. 32.—H. & A. AD., Gen. Rec. Moll. i, p. 481; iii, t. 55, f. 3.—*Chætopleura savatieri* ROCHEBRUNE, Bull. Soc. Philomathique de Paris, 1880–1881, p. 119; Miss. Sci. du Cap Horn, Polyplacophores, p. 135, t. 9, f. 3a, 3b.—*Chætopleura frigida* ROCHEBR., Miss. Sci. du Cap Horn, p. 137, t. 9, f. 5a, 5b. (young shell.)

This is the only well-established species known to inhabit the extremity of South America. It will be readily recognized by the smoothness of the surface, strong diagonal rib, and generally well-defined sutural pores, each bearing several bristles. The variation in color is well-shown on the plate. The *C. savatieri* (pl. 67, figs. 41, 42), and *C. frigida* (pl. 67, figs. 39, 40) of Rochebrune are merely, it seems to me, individual mutations of *setiger* the last being a young shell. It will not escape the observant zoologist that the artist who drew the plate of Chitons illustrating Rochebrune's paper, did not see the lateral slits in the valves. One is likely to infer that the other characters may be equally erroneously represented.

Some authors have given Gray's name *carmichaelis* to this species;

but this identification rests only upon the synonymy given in Gray's several lists. Waiving for the moment the question as to the identity of the original *carmichaelis* with *setiger*, we notice that the rest of Gray's synonymy of this species is in several respects incorrect. *C. biramosus* Quoy for instance, is not the same as *setiger;* and his list of Chitons shows a number of other errors of synonymy. It is not safe therefore to trust Gray's dictum in such matters; and it may fairly be doubted whether the original *carmichaelis*, which is described as being "scarcely keeled," one-half an inch long, etc., etc., is the same as the large, strongly carinated *Ch. setiger*. In any case, Gray's name should be ruled out on the score of faulty definition. The name *setiger* was acceptably defined; the species was correctly located by King; and it was sheer piracy on Gray's part to shift his name from some poor little half-inch Cape of Good Hope specimen to this fine large form from Cape Horn. The original description of *carmichaelis* is as follows:

Chiton carmichaelis Gray. Shell oblong, convex, scarcely keeled, smooth, bluish-brown streaked and lined with white; front valves with distant rather broad radiating nodulose ribs; front and back margins of the lateral areæ of the middle valves with a single similar rib; hinder valve smooth. Margin scabrous, brown. Length ½ an inch, breadth ⅜. Icon. Wood, Cat. Suppl., t. 1, f. 10. Inhab. Cape of Good Hope. Capt. Carmichael, Brit. Mus.

Chiton carmichaelis Gray, Spicil. Zool. pt. 1, p. 6 (July 1, 1828). Not *Plaxiphora carmichaelis* Gray, P. Z. S. 1847, pp. 68, 169.—*P. carmichaelis* Gray, Guide Syst. Dist. Moll. B. M., p. 186.

Var. fremblyi Broderip. Pl. 67, figs. 37, 38.

Shell oblong, flattened, olivaceous-brown, varied with whitish-green lines; anterior valve with elevated subgranose rays; intermediate valves angular at the sides, the lateral areas biradiate, rays subgranose, intervals longitudinally subsulcate. Girdle set with numerous short bristles.

Length 1¼, breadth 1 inch. (*Brod.*)

Bay of Valparaiso (Cuming).

Chiton frembleii Brod., P. Z. S. 1832, p. 28.—*C. setiger var. fremblii* Sowb., Conch. Illustr., p. 7, f. 4.—*Chætopleura hahni* Rochebrune, Miss. Cap Horn, Polyplac., p. 136, t. 9, f. 4 (1889.)

This differs from *P. setiger* in being somewhat wrinkled concentrically. I have not seen specimens. Broderip inserted an *e* in Frem-

bly's name, evidently by inadvertence.

The figures represent *C. hahni* Rochebr., which I believe to be identical. It is thus described:

Chætopleura hahni [pl. 67, figs. 37, 38]. Shell broad-ovate, flattened, obtusely carinated, violaceous-bluish, with spots and lines of brown irregularly distributed. Anterior valve rounded, with 10 radiating ribs. Posterior valve very small, elliptical, feebly beaked. Lateral areas of the median valves narrow, bounded by a beaded rib; central areas covered with deep concentric striæ, and very minutely striated transversely. Girdle wide, brown, covered with tawny hairs. Length 48, breadth 35 mill. (*Rochebrune.*)

P. BIRAMOSA Quoy & Gaimard. Pl. 68, figs. 51–54.

Animal ovoid, elongated, flattened, valves very transverse, little elevated, forming a low arch, not carinated; striated transversely in front. White or green with a circle of red-brown on each valve. The anterior valve has 9 teeth on its edge, the posterior valve none. The sutural laminæ are not wide, and are separated only by a very obtuse sinus. The insertion plates are slit at the sides at usual. Interior dull white.

Girdle nude, vivid red-brown, having two spaced series of rough, sparse and bifurcating hairs, the inner series contiguous to the valves, the other near the periphery of the girdle, which is also hairy. (*Q. & G.*)

Length 45, breadth 31 mill.

Chiton biramosus Q. & G., Voy. de l'Astrol. Zool. iii, p. 378, t. 74, f. 12–16.—*Plaxiphora biramosa* Q. & G., HUTTON, Man. N. Z. Moll. 1880, p. 116 (translation of Quoy's diagnosis).—*Acanthochætes biramosus* HUTTON, Trans. N. Z. Inst. iv, p. 181 (incorrect description, from Deshayes).—*Placiphora superba* CPR. *MS.*

The external form is noticeably different behind in the two individuals which we possess; but the red color of this species and its two series of bifurcating spines will readily distinguish it. (*Q. & G.*)

I believe the form which Carpenter described in *MS.* as *P. superba*, is the same as Quoy and Gaimard's *C. biramosus*. Carpenter's description is as follows:

P. superba (pl. 68, figs. 55–61). Shell large, oval, elevated, the dorsal ridge acute; mucro subposterior, little elevated. Reddish-olive, maculated with darker and paler. Valves nearly rectangular,

but well indented at the sutures, having a "false apex" in front. Lateral areas having indistinct, subobsolete radiating riblets. Anterior valve subangled by 8 radii, which slightly undulate the peripheral margin; otherwise nearly smooth except for growth-lines. Interior: posterior valve having the insertion-plate elevated, rounded, interrupted in the middle behind by a very narrow, deep sinus. Anterior valve having 8, central valves 1 slit; teeth long, slightly striated and slightly thickened at the edges of the slits outside. Sinus narrow, short. Sutural laminæ continuous over the anterior false apex. Girdle (fig. 61) tough; black, leathery, hardly sinuated behind, smooth, with a few bristles at the sutures and around the margin.

Length 60, breadth 40 mill.; divergence 110°.

New Zealand (Mus. Cum., no. 2.)

This very fine but unsculptured species was marked as new in Dr. Gould's collection, but not described by him. It is abnormal in the nearly smooth aspect of the tough girdle, in which however the binary pores (of which five surround the head valve) are distinctly marked. The shape of the valves is nearly as in *Mopalia wosnessenskii*. (*Cpr.*)

Professor Hutton has considered his *Tonicia corticata* a synonym of *biramosa*, in his Manual of New Zealand Mollusca, 1880; but the description (copied below) would hardly lead me to the same conclusion, although Hutton's species is undoubtedly a *Plaxiphora*. In sculpture it must resemble *P. terminalis*.

Tonicia corticata. Oval; margin naked; valves much depressed; posterior margins slightly concave; lateral areas bounded on each side by a flatly nodulose ridge, the space between being obliquely striated, the striæ running outward and backward; median areas rugose, without either distinct lines or granules. Length 1·25, breadth 1·13 inch. Color: margin black when dry; valves grey; inside white, covered over with white, coralline growth and small marine algæ. Founded on a specimen in the Colonial Museum, locality not stated. (Hutton, in Trans. N. Z. Inst. iv, p. 180, May, 1872.)

P. SIMPLEX Carpenter. Pl. 67, figs. 43, 44, 45, 46.

Shell similar to *P. modesta*, but more elevated, longer; valves rude, maculated with brown-purple; dorsal ridge rounded; mucro posterior, flattened; lateral areas scarcely defined; valves rounded,

with large sutures. Entire surface smooth, generally eroded, subspongy. Interior; posterior valve with a moderately elevated insertion-plate, moderately sinuated behind. Anterior valve with 8, median valves 1 slit; teeth acute, scarcely thickened at the edges of the slits. Eaves short, spongy. Sinus very narrow, smooth, straight. Girdle spongy, having very close, small hairlets, and longer corneous hairs scattered and at the sutures. (*Cpr.*)

Length 1·35, breadth ·7 inch, divergence 120°.

Var.: length 1·1, breadth ·65 inch, divergence 100°.

Tristan Island, Tristan da Cunha, on the shore, *and off Nightengale Island, Tristan da Cunha,* 100–150 fms. ('Challenger.')

Euplaciphora simplex Cpr., *MS.*—*Plaxiphora simplex* Cpr., in Haddon's Report on the Polyplacophora of the Challenger Expedition, p. 33. Also described by Haddon, *l. c.*, p. 34, t. 3, f. 13, 13*a–c*.

This species I have not seen. The *P. modesta* alluded to by Carpenter is a form of *P. petholata.*

Haddon describes *P. simplex* as follows:

Shell smooth, simply marked with line of growth, flat sides meeting at a variable angle. Anterior valve small, surface smooth. Under surface with eight slits, teeth fairly long, smooth and sharp; eaves short. Intermediate valve: Central area; smooth, flat. Lateral areas inconspicuous, with two or three very faint radiating ridges. Under surface with a median horizontal rib-like swelling; sutural laminæ broad, but not deep; jugal sinus wide and shallow; one lateral slit; eaves short. Posterior valve very small and flat, greatly corroded; umbo apparently flat and terminal; posterior border thickened. Under surface: sutural laminæ as in intermediate valves, but the jugal sinus is comparatively narrow and deep; slits and teeth absent; posterior border much swollen.

Girdle very thick and fleshy, upper surface having a spongy appearance, owing to being beset with very short horny spines, which are scarcely raised above the surface; there are tufts of longer spines, three to nine in each tuft, opposite the sutures of the valves; these have no definite position round the anterior valve. Situated outside these are numerous scattered similar tufts, usually somewhat smaller in size, which pass into an imperfect peripheral fringe of spines, (pl. 67, figs. 44, 46). Color: all the valves of a uniform dark brown, with a pale (lilac) narrow triangular band along the

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jugum of the intermediate valves (and anterior area of the posterior valve). Under surface of all the valves of a bluish-green color; laminæ of insertion paler. Girdle, upper surface dark brown; under surface dusky orange.

Length 40, breadth 25, height 10 mill.; angle of divergence 125° to 135° (two specimens from 100 to 150 fathoms.)

Length 25 to 35, breadth 14 to 17, height 8 to 9 mill.; angle 90° to 110° (two shore specimens.)

Group of P. wahlbergi.

No sculpture except some concentric lines; sinus deep, denticulate; girdle without sutural tufts.

P. WAHLBERGI Krauss. Pl. 55, figs. 17, 18.

Shell ovate-oblong, slightly convex; brown with a chestnut-brown median band and two yellowish longitudinal bands. Concentrically sulcate. Interior white, brownish-violet in the middle. Anterior valve semilunar; posterior valve subtriangular, depressed; intermediate valves subreniform, having distant concentric grooves on the front part of the central areas, and on the lateral areas. Girdle brown, leathery, velvety. Length 15, breadth 9 lines.

This species has rather thick, little convex valves, rounded on their outer ends, and having the older or posterior half of each eroded, and deprived of color and sculpture. Lateral areas not differentiated. The forward part and the sides of each valve have 6 or 7 separated, sometimes finely granulated furrows, parallel with the margins. The posterior margin is eroded, probably beaked in the middle. The insertion-plates are narrow, roughened outside. Anterior valve excavated behind, having 8 slits. Posterior valve lacking teeth. The valves have in the middle a chestnut-brown shining band, 2 mill. wide, on each side of which a yellow streak of greater or lesser width generally lies; but usually they are eroded and gray. (*Krauss.*)

Table Bay, Cape of Good Hope.

Chiton wahlbergi Krauss, Die Südafrik. Moll., p. 36, t. 3, f. 1 (1848).—*Euplaciphora wahlbergi* Cpr., *MS.*

May be known by the separated concentric grooves of lateral and central areas, parallel with the valve-margins, and also by the sinus, which is deep, narrow and denticulate, the last being an unusual character in this genus. The girdle has irregular setæ.

Group of P. petholata.

Shell somewhat sculptured. Girdle covered with crisp hairs, not forming bunches at the sutures, nor having pores there.

P. PETHOLATA Sowerby. Pl. 68, figs. 62, 63, 64, 65, 66, 67.

Shell elliptical or oblong, rather depressed, *the dorsal angle rounded* but side-slopes rather straight. *Surface finely corrugated at the sides, nearly smooth in the middle.* Color black or blue-black, with pink, creamy or greenish-white angular markings at the sides, and a wide triangle of the same light tint on the ridge of each valve, generally enclosing a dark, ill-defined dorsal stripe.

The median valves are slightly beaked. Lateral areas hardly raised, defined by a narrow, inconspicuous and slightly curved diagonal riblet, *the surface finely corrugated in zig-zag or vermiculate pattern. Central areas corrugated zigzagly at the sides, in front of the diagonal rib, the corrugation becoming finer toward the middle, and giving place to a microscopic pattern resembling a dense punctulation united with a minute zigzag or vermiculate wrinkling.* Anterior valve having about 9 narrow radiating riblets, the intervals densely and finely zigzag-punctate. Posterior valve depressed, wide and short, *the mucro at the posterior edge,* slightly acute and a little elevated; posterior area of the valve very narrow, ill-defined.

Interior dark *blue-green. Sinus deep, wide, angular, its edge light brown and very spongy.* Anterior valve having 8 slits, corresponding to external riblets, central valves 1 slit; the teeth acute, somewhat thickened at the edges of the slits. Posterior valve having a rather blunt, smooth insertion plate, interrupted by a shallow sinus in the middle behind. Eaves very narrow, spongy.

Girdle rather wide, black-brown and brown alternately, rather densely clothed with corneous or dark brown bristles, large and small, not in the least arranged in series or issuing from sutural pores.

Length 40, breadth 27 mill.; divergence 125°.

Length 32, breadth 18 mill.; divergence 130°.

Length 45, breadth 25 mill.

Australia (Sowb.); *Tasmania* (Cuming.)

Chiton petholatus SOWB., Mag. of Nat. Hist. New Series, iv, p. 289 (May, 1840); Conchol. Illustr., f. 64, 65, and var. *porphyrius*, f. 59.—REEVE, Conch. Icon., f. 74.—*Euplaciphora petholata* CPR., *MS.* Not *Plaxiphora petholata* ANGAS, P. Z. S. 1865, p. 187 and

1867, p. 224.—*Euplaciphora modesta* Cpr., *MS.*

The sinus is squared, and the internal layer is bevelled off exposing the very porous outer layer as in *Nuttallina*. Back of this porous area, the width of which varies, the surface shows transverse cuts or puncture-slits. The hairs of the girdle show no trace whatever of arrangement in tufts or pores. The exterior is finely sculptured with zigzag wrinkles, and the diagonal riblets on each valve, as well as the radii on the head valve, may be either nearly smooth or closely granose. The pattern of coloring is characteristic but still quite variable.

Var. conspersa Adams & Angas.

Shell oval, little elevated, with obtuse dorsal ridge. Ashy, with a few scattered clouds of dark and olivaceous.

Valves squared, thin; apices not conspicuous, jugal areas marked off by slight indentations which are slightly divergent; but otherwise finely sculptured like the rest of the middle part of the central areas; pleura having about 20 irregularly roughened liræ on each side, the liræ mainly forming right angles with the diagonal rib, but branching and minutely undulating; becoming very fine toward and upon the jugum; interstices very small. Lateral areas with the diagonal rib much elevated, rendered nodulous by the wrinkles passing over it; the same sculpture extending across the lateral areas and becoming more nodulous at the suture. Anterior valve having 8 ribs, besides those at the sutures. Posterior valve having the mucro at the posterior fourth, and with two diagonal ribs.

Interior: anterior valve having 8 slits, median valves 1 slit, corresponding to the external ribs; the teeth slightly thickened at the edges of the slits. The posterior valve has well developed, sharp insertion-plates on each side.

Girdle pale brown, maculated with black-brown; bearing fine, sparsely scattered soft corneous hairs.

Length 21–22, breadth 12–14 mill., divergence 117°.

Port Lincoln, South Australia, under rocks (Angas.)

Chætopleura conspersa Ad. & Ang., P. Z. S. 1864, p. 193.—Angas, P. Z. S. 1865, p. 187.—*Placiphora conspersa* Cpr., *MS.*

I have seen no specimens of this form, which Carpenter believed to be a variety of *P. petholata*. The above description is from Carpenter's *MS.*, and was drawn from Angas' type.

P. CARPENTERI Haddon. Pl. 67, figs. 33, 34, 35, 36.

Shell smooth, the sides meeting at an angle of 105°. Anterior valve with eight radiating ridges, not counting the swollen posterior borders. Numerous concentric minor ridges cause these ridges to be rugose. Under surface with nine slits, two being very close together; eaves short.

Intermediate valves: central area smooth, with fine lines of growth; no distinct keel. Lateral areas prominent, concentrically rugose, with a beaded ridge along the anterior border, and, to a less extent, along the posterior border. Under surface with a median horizontal rib-like swelling; sutural laminæ broad, but not deep; jugal sinus shallow; one lateral slit; eaves short. Posterior: valve anterior area so large as to reduce the posterior area to a minimum; smooth; umbo minute, nearly terminal. Posterior area merely forms a concentrically grooved thickening of the posterior border of the valve. Under surface: sutural laminæ as before, but the jugal sinus is comparatively narrow and deep; slits and teeth absent; the posterior border is greatly swollen.

Girdle closely beset with very minute horny spines. The specimen had been dried when I received it, and none of the longer spines, characteristic of other species, are observable; but I think I can discern traces of small sutural tufts.

Color: anterior valve with a median triangular area, with the apex at the umbo, is of a kind of chocolate color, which is variegated with minute zigzag grey lines; the lateral spaces are of a dark slate color. Intermediate valves: central area: jugum pink; greenish toward the umbo when worn down. Pleura dark greenish-brown, with irregular longitudinal green bands. Lateral areas madder brown, blotched with brown. Posterior valve: anterior area resembling the central areas; posterior border pinkish. Under surface of all the valves pale bluish green; laminæ of insertion white. Girdle reddish-brown.

Length 14, breadth 9 mill.; height 4 mill. (*Haddon.*)

Tristan da Cunha.

Plaxiphora carpenteri HADDON, Challenger Rep. Polyplac., p. 34, t. 1, f. 8; t. 3, f. 8*a-g*.

The sculpture of the shell, slight as it is, is sufficient to characterize this species. (*Haddon.*)

P. GLAUCA Quoy & Gaimard. Pl. 68, figs. 68–72.

Animal oval, widened at the sides. Valves wide, rounded, little

elevated, subtriangular, uniform and smooth except toward the anterior margins where they are marked with three or four marginal striæ; they are black toward the lateral margins, with a triangle of the same color in the middle, bordered with yellowish or greenish.

Inside they are of a beautiful emerald green, the sutural laminæ being of the same color and separated by a wide sinus. The anterior valve has its margin cut into 9 smooth teeth. Posterior valve having a semi-circular ridge in place of the teeth. The valves taken together form an elongated oval. All of the intermediate valves have one slit and two transverse striæ on the apophyses.

Girdle of a beautiful light green, covered with rigid but not acute bristles of the same color. (*Q. & G.*)

Length 50, breadth 37 mill.

d'Entrecasteaux Channel, Tasmania.

Chiton glaucus Q. & G., Voy. de l'Astrol. Zool. iii, p. 376, t. 74, f. 7–11 (1834). Not *Chiton glaucus* GRAY, an undetermined species, see p. 172.—? *Plaxiphora ciliata* ANGAS, P. Z. S. 1865, p. 187, not *Chiton ciliatus* SOWB.

This species is evidently allied to *P. petholata.* It is probably the form Angas collected at Guichen Bay, South Australia, and listed as "*P. ciliata.*" He found it on rocks at low water, and remarks that it is the largest of the South-Australian Chitonidæ.

Group of P. terminalis.

Sculpture stronger than in *P. petholata.* Girdle generally with more or less distinct sutural pores. Distribution, New Zealand.

P. TERMINALIS (Cpr.) Smith. Pl. 51, fig. 14.

Shell resembling *P. petholata* in sculpture, but more elevated, longer, the mucro entirely terminal, produced. Dorsal ridge striped with white. Sculpture much more distinct, consisting of irregularly zigzag wrinkles all over, coarser at the sides.

Interior having 8 slits in the anterior, 1 in the median valves. Posterior valve with subplanate insertion plate; the subjugal area punctate, teeth, sinus and eaves as in *P. petholata.* Girdle having bunches of long horny hairs at the sutures and around the margin, elsewhere smoother.

Length 25, breadth 12½ mill.; divergence 120°. (*Cpr.*)

New Zealand (Cuming.)

Plaxiphora terminalis CPR., *MS.* in Mus. Cuming.—*Chiton* (*Plaxiphora*) *terminalis* E. A. SMITH, Voy. Erebus and Terror, Moll., p. 4, t. 1, f. 13 (1874).—*Plaxiphora terminalis* Smith, HUTTON, Man. N. Z. Moll. 1880, p. 116 (reprinted from Smith.)

Smith has described this species in detail, as follows: "Shell elongately ovate, rather elevated, roundly angled along the top of the valves, black or bluish-black, with a white wedge-shaped stripe with a black one within it down the centre of the valves, forming a continuous white stripe divided by the black one along the center of the shell, in some specimens with a few short white dashes diverging from the radiating ridges. The intermediate valves mucronated, bisected on each side by one raised radiating rib, the posterior margins sinuated and thickened by coarse concentric lamellæ; the entire surface is covered with minute striate-wrinkling, those near the ridge being coarser than the rest and radiating from it like the webs from the shaft of a feather. The posterior terminal valve has the mucro quite terminal. The anterior valve radiately eight-ribbed (at times one or two additional minor ones are present) with diverging oblique striations on each side of them. Interior of valves greenish-blue; valve lobes whitish, the sinus between them deep; the hairs or bristles on the mantle-margin are short, few and horny, those arising from the nine pores being thicker than the rest.

"Largest specimen (in a contracted state) 42 mill. long; width of valves, 20 mill.; an average specimen, length 25 mill.; width 11 mill.

New Zealand (Col. Bolton and Capt. Stokes.)

"*Terminalis*" appears to be but a manscript name attached to some specimens in the Cumingian collection. As I understand that Dr. P. P. Carpenter is engaged on a work on *Chitonidæ* I retain the characteristic name he imposes: The central white stripe with the black one within it appears to be very constant."

Carpenter gave the varietal name *zigzag*, (in *MS.*) to specimens in the Cuming collection (no. 31) having stronger sculpture, one more anterior riblet, etc. It seems to be merely an individual variation.

P. EXCURVATA Carpenter, n. sp.

Shell elongated, elevated, the dorsal ridge rounded, valves angled at the sides, obtusely beaked, the sutures indented. Irregularly maculated with coppery green and black.

Lateral areas defined by an obtuse curved rib; toward the rib on

each side closely concentrically sulculate. Anterior valve having about 7 or 8 ribs, sometimes with some intercalated subobsolete riblets. Posterior valve small, the mucro subposterior, swollen.

Interior blue. Anterior valve having 7–8, median valves 1 slit; teeth long, acute, scarcely thickened at edges of the slits. Posterior valve having an obtuse insertion plate, a little sinuated in the middle behind. Sinus broad, straight, spongy.

Girdle wide, thin, hardly sinuated behind, tessellated with brown and ashy, beset all over with sparse, delicate, short setæ, longer at the sutures.

Length 70, breadth 39 mill.; divergence about 110°.

Australia? (Haines Coll., and Coll. McGill University, Montreal.)

Euplaciphora excurvata Cpr., *MS.*

This shell has a general external resemblance in size and shape to *P. cuprea*, from which it is known at once by the color and sculpture outside, by having no posterior slit in the girdle, and inside by the smoothness and sharpness of the insertion-plates. It also resembles *P. superba*, but is entirely destitute of sutural pores.

P. cælata Reeve. Pl. 58, figs. 21, 22.

Shell oblong-ovate, somewhat attenuated anteriorly, terminal valves (the posterior of which is small and slanting) and lateral areas of the rest broad-ribbed and neatly carved with close-set waved laminæ; central areas very minutely reticulated. Beautifully ornamented with green and pink. Ligament horny, here and there bristly. (*Reeve.*)

New Zealand (Earl, Cuming.)

Chiton cælatus Rv., Conch. Icon., t. 17, f. 101 (1847).—*Streptochiton cupreus* Cpr., *MS., olim.*—? *Tonicia zigzag* Hutton, Trans. N. Z. Inst. iv, p. 181 (1872.)

The verdigris green and peculiar pink color-pattern is characteristic and singularly beautiful.

Von Martens has stated that *Tonicia zigzag* Hutton is a synonym of "*Acanthopleura*" *cælata* Rv. (Crit. Cat., p. 49); a conclusion accepted by Hutton (Man. N. Z. Moll., p. 115, 1880). As in other cases of alleged identity, the original type of *zigzag* should be re-examined. Hutton's description is as follows:

Tonicia zigzag Hutton. Oblong; mantle slightly tomentose; valves slightly flattened on each side, but not keeled; posterior

margins sloping backwards into a point, crenulated on the sides; anterior valve with 9 radiating ridges crossed by fine concentric zig-zag striæ; lateral areas with two, on each side, radiating ridges crossed by fine zig-zag striæ; posterior and median areas with very fine oblique striæ diverging from the dorsal line outward and forward crossed by others diverging outward and backward forming an engine-turned pattern. Length 88 inch.; breadth 31 inch.

Color, mantle white; valves greyish-black with a white stripe on each side of the dorsal line; interior greenish-blue.

A single specimen is in the Colonial Museum, locality not stated. (*Hutton.*)

*

The following species probably belongs here, but I have seen no specimen, and it has not been figured.

CHITON (CHÆTOPLEURA) PLUMOSUS Gould.

Shell brown-ashy, valves concave scarcely beaked; anterior valve ornamented with plumose radiating liræ; posterior valve small, the apex marginal and having a submarginal rib on each side. Central area large, ornamented with divaricating striæ, and lateral plumosely co-united striæ. Lateral areas small, bounded by a sutural rib, striæ denticulated, interspaces clathrate. Girdle broad, leathery, furnished with (bristly?) tubules.

Length 1·5, breadth ·75 inch. (*Gld.*)

Habitat unknown.

Allied to *C. cælatus* Rv., which is said to be highly ornamented with green and pink. *C. collei* and *C. muscosus* G. belong to the same group. (*Gld.*, in Proc. Bost. Soc. Nat. Hist. vii, p. 165.)

Section *Guildingia* Cpr., 1893, n. sect.

Guildingia CPR., *MS.*, and in Dall, Proc. U. S. Nat. Mus. 1881, pp. 284, 288 (type *G. obtecta* Cpr. *MS.*)

Shell and girdle like *Plaxiphora*, except that the valves are partly immersed by the encroachment of the girdle.

This section, like *Fannettia* in the genus *Tonicia*, rests upon a character of very little taxonomic value; but as it is useful in breaking up a large genus for convenience in identifying, it has been retained.

P. OBTECTA Carpenter, n. sp.

Shell large, broad, partly covered. Valves smooth, most minutely punctulate angulate in front; sutural sinus large, produced forward over the jugum; lateral areas scarcely defined except by an angle at the forward outer margin of the valves; dorsal ridge rounded. Intense olivaceous, paler on the dorsal ridge. Mucro of posterior valve terminal hardly produced.

Interior: posterior valve with flattened insertion-plates. Anterior valve with 8, central valves 1 slit; teeth very acute, long, smooth, a little thickened at the slit-edges; eaves narrow, spongy. Sinus deep, very obtusely angular, with a spongy area. Sutural laminæ long, separated. Girdle very broad, sinuated behind, with bundles of about three large, horn-like hairs at the sutures, and having smaller ones sparsely scattered all over more or less closely. (*Cpr.*)

Length 50, breadth 32 mill.; divergence 120.°

New Zealand (Mus. Cum., no. 45.)

This very interesting shell differs from the typical *Plaxiphoræ* as *Fannettia* does from *Tonicia*. It is, however, simply an exaggeration of *P. terminalis*.

Section *Fremblya* H. Adams, 1866.

Frembleya H. AD., P. Z. S. 1866, p. 445. Type *F. egregia* H. AD.—*Fremblya* CPR., *MS.* and in Proc. U. S. Nat. Mus. 1881, p. 284. —*Streptochiton* CPR., *MS. olim.*

Shell and girdle like *Plaxiphora* except that the former is short and broad, the tail valve very much reduced in size, strongly arched upward in the middle behind. Slits in intermediate valves posteriorly situated. Girdle having more or less obvious sutural pores.

The sculpture of these forms is like that of the more elaborately carved Plaxiphoras of the same regions; but the considerable modification in the general form of the tail valve may be held to be sufficient ground for the retention of Adams' generic name in a sectional sense. The organization throughout is otherwise very similar to that of *Plaxiphora*. Two species only are known: *P. egregia*, in which the shell is of a peculiar egg shape, wider behind the middle, and the insertion plates are much thickened outside at the edges of the slits, and *P. ovata*, in which the shell is widest at the fourth valve, rapidly narrowing toward both ends.

The following description of his new genus is given by H. Adams:

"*Frembleya*, gen. nov. Testa ovalis, convexa. Valvæ transversæ, latæ, carinatæ; apex posterioris valvæ terminalis, producta, fissa. Limbus angustus, postice fissus, setis corneis dense obsitus. The covering of the mantle, the form of the visible portions of the valves, and the peculiarity of the terminal valve, render this species distinct from any form of Chitonidæ yet described. It has the appearance of a *Lorica* with the mantle covered with long bristles instead of imbricate scales."

There seems to be no reasonable objection to the correction of the etymology of Frembly's name, which in H. Adams' article was incorrectly spelled through inadvertence or typographical error.

P. EGREGIA H. Adams. Pl. 65, figs. 80, 81, 82.

Shell ovate, a little narrower in front, green-brown, paler at the sides. Anterior valve radially ribbed, the ribs pustulose, interstices obliquely lirate; posterior valve and median valves subcarinate, the dorsal areas densely longitudinally lirate; lateral areas radially ribbed, the ribs pustulose. Girdle moderate, furnished with short, corneous spicules. (*H. Ad.*)

Length 15, breadth 9 mill.

"*Habitat unknown*" (Ad.); *Newcastle, Australia* (Dieffenbach, *teste* Cpr.)

Frembleya egregia H. AD., P. Z. S. 1866, p. 445, t. 38, f. 9.—*Streptochiton tortuosus* CPR., *MS., olim.*

Of this species I have seen a single mutilated specimen, no. 36,638 of the Smithsonian Institution register. It is yellowish along the middle and at the side margins of the valves, pale green on the side-slopes. The species differs from *P. ovata* in being *widest behind the middle.* Carpenter describes the type as follows: Shell olivaceous, maculated with more or less intense; ovate, broad, elevated; dorsal ridge rather acute, much elevated, the side-slopes straight. Valves strongly beaked, each one eroded in front from the attrition of the next valve forward. The central areas have about 16 liræ on each side, about equalling the interspaces in width. Lateral areas elevated, bicostate, the ribs strongly granose, granules larger at the sutures, intermediate space obliquely costate or v-costate. Anterior valve having 10 radiating ribs, the interstices sculptured with v-shaped sulci, the v'-s meeting over the ribs and rendering them somewhat nodulous. Posterior valve with posterior elevated mucro and a single posterior rib on each side; posterior area very narrow

and smooth. The girdle has soft hairs, and a few larger, and there is some trace of pores. The posterior slit in the girdle mentioned by Adams seems to be an accidental tear; H. Adams believes the same.

Length 15, breadth 10 mill.; divergence 133°.

P. OVATA Hutton. Pl. 54, figs. 34–40.

Shell *short-oval, very wide in the middle, rapidly narrowing toward the ends;* moderately elevated, the dorsal ridge carinated, side slopes slightly convex. Surface lusterless, sculptured in "herring-bone" pattern. Color buff along the ridge, pale olive-green on the side-slopes, with a small curved dark spot or two on each valve.

Median valves broadly v-shaped, the apices of the valves elevated and acute. Lateral areas narrow, a little raised, the diagonal rib sculptured with a series of closely super-imposed v's, their apices directed toward the beak of the valve, one limb of each v directed outward, curving, and forming the sculpture of the pleura, the other limb forming an oblique corrugation of the lateral area (fig. 40). Sutural margin of each lateral area obliquely, coarsely granose. Central areas having a nearly smooth band along the dorsal ridge, and numerous slightly curving and diverging riblets on each side. Anterior valve small, its width about that of one side-slope of the fourth valve, its apex elevated and slightly recurved; surface having 8 strong ribs, besides those at the sutural margins, the anterior ribs strongest and wider apart; ribs nodose, intervals obliquely corrugated. Posterior valve (figs. 36–39) small, forming an extremely narrow crescent, strongly curved upward at the acute posterior mucro, the front ("central") area narrow, concave; viewed from behind (fig. 37) it presents the appearance of a wide inverted v.

Interior bluish-white. Sinus exceedingly broad, rounded, the sutural-plates widely separated. Insertion plates long, having the slit near the posterior edge of the plate. Anterior valve having 8, median valves 1 slit. Posterior valve (fig. 39) having a keel-like insertion-plate without slits on each side, and a broad sinus in the middle behind.

Girdle rather narrow, yellowish, bearing a pore-tuft of hyaline white bristles at each suture and a fringe of bristles at the edge.

Length 15, breadth 13 mill.; divergence 112°.

Cook Strait; Dunedin, New Zealand; on seaweed.

Acanthochætes ovatus HUTTON, Trans. N. Z. Inst. iv, p. 182 (1872).

—*Acanthochites ovatus* HUTTON, Man. N. Z. Moll., p. 177 (1880.)

This species differs from *P. egregia* in contour, the fourth valve being the widest, the sixth much narrower, whilst in the other species the fifth and sixth valves are as wide as the fourth; moreover the side teeth of *ovata* do not seem to be thickened at the edges of the slits as they are in *egregia*. The specimen described and figured was sent by Professor Hutton.

ERRATA.

Page 75, dele the word ISCHNOCHITON, in 8th line.

Page 97, I. CURTISIANUS is not an *Ischnochiton* but a Liolophura, see p. 242.

Page 110, For "*I. regulatus*" read "*I. rugulatus.*"

Page 133, "I. PUSIO" is probably not an *Ischnochiton*, but a true *Chiton*, and it is likely to prove identical with *Chiton murrayi* Haddon, described on p. 161.

Page 151, line 11, for "indentification" read "identification."

Page 182, last line, remove "*C. scytoderma*" from the synonymy of *C. rubicundus.*

Page 191. The authority for C. SULCATUS should be "Wood," not "Sowerby."

Page 204, line 14, for "indentification" read "identification."

Page 206, fifth line from bottom; the reference to Savigny should read "t. 3, f. 6, 1–2," instead of "f. 4."

Page 329. "*Chiton* (*Acanthopleura*) *piceolus*" Shuttlew., included under *Acanthopleura granulata* as a doubtful synonym, is probably referable to the genus NUTTALLINA, s. g. *Middendorffia*, and it should be compared with *N. cinerea* Poli, p. 283.

NOTE.

The Index to Chitons will accompany the conclusion of the monograph, to be contained in the next part of the MANUAL.

EXPLANATION OF PLATES.

NOTE.—The drawings credited to Foord, Smith and Emerton were prepared under the supervision of Dr. Carpenter, and were loaned by the Smithsonian Institution, for reproduction in the MANUAL.

PLATE 1.

FIGURE.		PAGE.
1–13.	Lepidopleurus benthus Haddon. Challenger,	9
14–22.	Lepidopleurus belknapi Dall. Challenger,	7

PLATE 2.

23–31.	Lepidopleurus alveolus Sars. Moll. Arct. Norv.,	6
39, 40.	Lepidopleurus pagenstecheri Pffr. Moll. S. Georg.,	12
41, 43-46.	Lepidopleurus cajetanus Poli. Ross del.,	15
42.	Lepidopleurus cajetanus Poli. Conch. Icon.,	15
47–50.	Lepidopleurus granoliratus Cpr. Pilsbry del.,	14
51–53.	Lepidopleurus granoliratus Cpr. Foord del.,	14

PLATE 3.

54–57.	Lepidopleurus cancellatus Sowb. Moll. Reg. Arct.,	3
58.	Lepidopleurus cancellatus Sowb. Ross del.,	3
59–63.	Lepidopleurus arcticus Sars. Moll. Reg. Arct.,	5
64–66.	Lepidopleurus asellus Speng. Ross del.,	13
67–70.	Lepidopleurus rugatus Cpr. Pilsbry del.,	11
71–79.	Hanleya hanleyi Bean. Moll. Reg. Arct.,	17

PLATE 4.

74–77.	Hanleya hanleyi var. abyssorum Sars. Moll. Reg. Arct.,	18
78–81.	Lepidopleurus curvatus Cpr. Emerton del.,	16
82–84, 85.	Hanleya mendicaria M. & A. Emerton del.,	18
83.	Hanleya mendicaria M. & A. Inv. Mass.,	18
86.	Lepidopleurus rarinotus Jeffr. P. Z. S.,	See Appendix.
87.	Lepidopleurus catillus Rv. Conch. Icon.,	10
88.	Lepidopleurus fuliginatus Ad. & Rv. Conch. Icon.,	10

PLATE 5.

89–100.	Hemiarthrum setulosum Cpr. Challenger Rep.,	20

1–3. Hemiarthrum setulosum Cpr. Moll. S. Georg., . . 20
4–8. Hemiarthrum setulosum Cpr. Emerton del., . . 20

Plate 6.

9–11. Microplax grayi Ad. & Ang. E. A. Smith del., . 21
12–16. Hanleya tropicalis Dall. Emerton del., ... 19
17, 18. Hanleya tropicalis Dall. 'Blake' Moll., . . . 19
19, 21. Trachydermon steinenii Pffr. Moll. S. Georg., . . 82
22–24. Trachydermon lividus Midd. Mal. Ross., . . 76
25–27. Trachydermon cinereus L. Moll. Reg. Arct., . . 68
28. Trachydermon cinereus L. Ross del., ... 68
29, 30. Trachydermon cinereus L. Pilsbry del., . . . 68
31. Trachydermon cinereus L. Hist. Br. Moll., . . . 68
32–34. Trachydermon albus L. (head and tail valves badly drawn). Emerton del., ... 70

Plate 7.

35. Trachydermon albus L. Moll. Reg. Arct., . . . 70
36–38. Trachydermon albus L. Pilsbry del., . . . 70
39–45. Trachydermon exaratus Sars. Moll. Reg. Arct., . 71
46–49. Trachydermon exaratus Sars. Tr. Conn. Acad., . 71
50–56. Trachydermon ruber L. Moll. Reg. Arct., . . 80
57. Trachydermon cinereus L. Pilsbry del., . . . 68
58. Trachydermon cinereus var. variegatus Phil. Moll. Sicil., 69
59–60. Trachydermon cinereus var. variegatus Phil. Moll. Rouss., ... 69

Plate 8.

61–65. Trachydermon dentiens Gould. Pilsbry del., . . 73
66–68. Trachydermon scrobiculatus Midd. Mal. Ross., . 76
69, 70. Trachydermon pusillus Sowb. Conch. Icon., . . 80
71. Trachydermon stramineus Sowb. Conch. Ill., . . 79
72, 73. Trachydermon virgatus Rv. Conch. Icon., . . 78
74, 75. Trachydermon virescens Rv. Conch. Icon., . . 78
76, 77. Trachydermon puniceus Couth. Expl. Exped., , 81
78, 79. Chætopleura cullierti Rochebr. Moll. Cap Horn, [See Appendix
80, 82. Callochiton fulgetrum Reeve. Conch. Icon., . . 83
81. Callochiton fulgetrum Reeve. Cpr. del., ... 83
83–85. Callochiton lobatus Cpr. Emerton del., . . . 53

Plate 9.

86, 87, 91. Callochiton castaneus Wood. Conch. Ill., . . 52
88, 89, 90. Callochiton castaneus Wood. Pilsbry del., . . 52
92. Callochiton illuminatus Rve. Emerton del., . . . 51
93, 94. Callochiton illuminatus Rve. Conch. Icon., . . 51

95, 96. Callochiton lævis Mont. Pilsbry del., . . . 49
97, 98. Callochiton lævis Mont. Hist. Br. Moll., . . . 49

Plate 10.

1, 2. Callochiton platessa Gld. U. S. Exped., . . . 49
3, 4, 5. Callochiton platessa Gld. Emerton del., . . 49
6. Callochiton versicolor Ad. (=platessa Gld.). P. Z. S., . 50
7. Callochiton crocinus Rve. (probably distinct from versicolor). Conch. Icon., ... 50
8, 10–15. Tonicella marmorea Fabr. Moll. Reg. Arct., . 41
16–21. Tonicella submarmorea Midd. Emerton del., . . 42
22–24. Tonicella submarmorea Midd. Mal. Ross., . . 42

Plate 11.

25, 27. Tonicella lineata Wood. Ross del., ... 42
26. Tonicella lineata Wood. Emerton del., ... 42
28. Tonicella lineata Wood. Pilsbry del., ... 42
29–31. Tonicella sitchensis Midd. Mal. Ross., . . . 44
32–34. Schizoplax brandti Midd. Sib. Reise, . . . 47
35–37. Schizoplax brandti Midd. Emerton del., . . . 47
38, 39. Leptoplax coarctatus Sowb. Emerton del., . . 25
40, 41. Ischnochiton interstinctus Gld. U. S. Ex. Exped., . 119

Plate 12.

42. Chætopleura peruviana Lm. Ross del., ... 28
43–46. Chætopleura peruviana Lm. Emerton del., . . 28
47. Chætopleura hennahi Gray. Conch. Icon., . . . 29
48, 49. Chætopleura hennahi Gray. Ross del., . . . 29
50. Chætopleura parallela Cpr. Ross del., ... 34
51. Chætopleura columbiensis Sowb. Conch. Illust., . . 34
52. Chætopleura columbiensis Sowb. Conch. Icon., . . 34
53, 54. Chætopleura lurida Sowb. Conch. Icon., . . . 33
55, 56. Chætopleura scabriculus Sowb. (=lurida). Conch. Ill., ... 33, 34

Plate 13.

57, 58. Chætopleura isabellei Orb. Voy. Amér. Mérid., . 35
59. Chætopleura janeirensis Gray. Conch. Ill., . . . 37
60. Chætopleura janeirensis Gray. Pilsbry del., . . . 37
61, 62. Chiton segmentatus Rv. Conch. Icon.(=Chætopleura janeirensis), ... 37
63, 64. Chætopleura spinulosa Gray. Conch. Icon., . . 38
65, 66. Chætopleura dieffenbachi Rve. Conch. Icon., . . 35
67, 68. Chætopleura sowerbyana Rve. Conch. Icon., . . 39
69, 70. Chætopleura gemmea Cpr. Emerton del., . . 31
71–74. Chætopleura gemmea Cpr. Ross del., . . . 31

Plate 14.

80. Chætopleura nobilis Rve. Conch. Icon., . . . 30
81. Cyanoplax hartwegi Cpr. Original, ... 45
82, 83. Cyanoplax hartwegi Cpr. Emerton del., . . . 45
84, 85. Cyanoplax hartwegi Cpr. Ross del., . . . 45
86–89. Ischnochiton acrior Cpr. Ross del., . . . 61
90. Cyanoplax bipunctatus Sowb. Conch. Ill., . . . 46

Plate 15.

91, 93. Ischnochiton conspicuus Cpr. Ross del., . . . 63
92, 96. Ischnochiton conspicuus Cpr. Pilsbry del., . . 63
94, 95. Ischnochiton conspicuus Cpr. Emerton del., . . 63
97. Ischnochiton conspicuus var. solidus Cpr. Emerton del., 64
98, 100. Ischnochiton magdalenensis Hds. Ross del., . . 62

Plate 16.

1, 2. Ischnochiton alatus Sowb. Emerton del., . . . 60
3, 4. Ischnochiton alatus Sowb. Pilsbry del., . . . 60
5. Ischnochiton alatus Sowb. Ross del., ... 60
6–8. Ischnochiton juloides Ad. P. Z. S., ... 55
9, 10. Ischnochiton limaciformis Sowb. Ross del., . . 57
11, 12. Chiton productus Rv. (=I. limaciformis). Conch. Icon., ... 57
13, 14. Chiton sanguineus Rv. (=I. limaciformis). Conch. Icon., ... 57
15, 16. Ischnochiton limaciformis Sow. Conch. Icon., . . 57
17, 18. Ischnochiton fallax Cpr. Emerton del., . . . 59

Plate 17.

19, 20. Ischnochiton floridanus Pils. Ross del., . . . 58
21, 22. Ischnochiton floridanus Pils. Pilsbry del., . . 58
23, 23. Ischnochiton purpurascens Ad. Ross del., . . 58
24. Ischnochiton purpurascens Ad. Emerton del., . . 58
25 26. Ischnochiton pectinatus Sowb. Ross del., . . . 64
27, 28. Ischnochiton pectinatus Sowb. Emerton del., . . 64
29. Ischnochiton pectinatus Sowb. Pilsbry del., . . . 64
30. Chiton acutiliratus Rv. (=I. pectinatus Sowb.). Conch. Icon., ... 64, 65
32, 33. Ischnochiton viridulus Couth. U. S. Exped., . . 141
39. Chætopleura hennahi Gray. Pilsbry del., . . . 29

Plate 18.

35–39. Ischnochiton tridentatus Pilsbry. Pilsbry del., . 140
40. Ischnochiton trifidus Cpr. Cpr. del. (*see appendix*), . 141
41–46. Ischnochiton regularis Cpr. Emerton del., . . 142

47, 48. Ischnochiton dispar Sowb. Conch. Icon., . . . 111
49, 50. Ischnochiton inquinatus Rve. Conch. Icon., . . 90
51–55. Ischnochiton adamsii Cpr. Pilsbry del., . . . 111
56, 57, 59. Ischnochiton australis Sow. Pilsbry del., . . 144
58. Ischnochiton australis Sow. Conch. Icon., . . . 144

Plate 19.

60, 61. Ischnochiton tigrinus Krauss. Südafrik. Moll., . 143
62, 63. Ischnochiton tigrinus var. unicolor Pils. Pilsbry del., ... 143, 144
64–66. Ischnochiton hakodadensis Cpr. Pilsbry del., . 147
67. Ischnochiton novæhollandiæ Gray. Pilsbry del., . . 145
68. Ischnochiton novæhollandiæ Gray. Ross del., . . 145
69. Ischnochiton novædollandiæ Gray. Conch. Icon., . . 145
70–74. Ischnochiton albrechti Schrenck. Amurl. Moll., . 147

Plate 20.

1–4. Ischnochiton rissoi Payr. Bull. S. Mal. Ital., . . 102
5–7. Ischnochiton rissoi Payr. (young). Bull. S. Mal. Ital., 102
8–10. Ischnochiton rissoi var. meneghinii. Journ. Conch., . 103
11. Ischnochiton yerburyi Smith. P. Z. S., ... 101
12, 3, 14, 15. Ischnochiton oniscus Kr. Südaf. Moll., . 100
16, 17. Ischnochiton reticulatus Rv. Conch. Icon., . . 101
18, 19. Ischnochiton pertusus Rv. Conch. Icon., . . . 103
20. Ischnochiton striolatus Gray. Conch. Icon., . . . 105
21–24. Ischnochiton striolatus Gray. Ross del., . . . 105
25, 26. Ischnochiton caribæorum (Cpr.) Smith (=I. striolatus). J. Linn. Soc., ... 107

Plate 21.

27, 28. Ischnochiton pruinosus Gld. U. S. Expl. Exped., . 109
29–34. Ischnochiton imitator Smith. P. Z. S., . . . 116
35, 38. Ischnochiton punctulatissimus Sowb. Conch. Ill., . 115
36, 37. Ischnochiton punctulatissimus Sowb. Pilsbry del., . 115
39. Ischnochiton interstinctus Gld. Pilsbry del., . . 119
40, 41. Ischnochiton papillosus Ad. Ross del., . . . 114
42–46. Callistochiton shuttleworthianus Pils. Pilsbry del., . 273
47, 48. Ischnochiton catenulatus Sowb. Conch. Illust., . 110
49. Ischnochiton roseus Sowb. Conch. Icon., . . . 113
50. Ischnochiton roseus Sowb. Conch. Illustr., . . . 113
51, 52. Ischnochiton colubrifer Rve. Conch. Icon., . . 95
53. Ischnochiton rugulatus Sowb. Beechey's Voy., . . 110
54–56. Ischnochiton rugulatus Sowb. Conch Ill., . . 110
57. Ischnochiton rugulatus Sowb. Conch. Icon., . . . 110

Plate 22.

58. Ischnochiton longicymba Q. & G. Ross del., . . 87
59. Ischnochiton longicymba Q. & G. Astrol., . . . 87
60–66. Ischnochiton longicymba Q. & G. Pilsbry del., . 87
67, 72, 73. Ischnochiton haddoni Pils. Pilsbry del., . . 88
68, 70, 71. C. longicymba Sow. (=I. haddoni Pils.). Conch. Ill., ... 88
69. C. longicymba Rve. (=I. haddoni Pils.). Conch. Icon., . 88
74. Ischnochiton divergens Rve. Pilsbry del., . . . 90
75, 76. Ischnochiton divergens Rve. Ross del., . . . 90
77. Ischnochiton divergens Rve. Conch. Icon., . . . 90

Plate 23.

78, 80. Ischnochiton fruticosus Gld. U. S. Ex. Exped., . 91
79. Ischnochiton fruticosus Gld. Pilsbry del., . . . 91
81, 82. Ischnochiton contractus Rve. Conch. Icon., . . 93
83, 84. Ischnochiton decussatus Rve. (=contractus). Conch. Icon., ... 93, 94
85. Ischnochiton exiguus Sowb. Conch. Illustr., . . . 98
86. Ischnochiton exiguus Sowb. Conch. Icon., . . . 98
87, 88. Ischnochiton castus (=contractus). Conch. Icon., 93, 94
89, 90. Ischnochiton sculptus Sowb. Conch. Illustr. . . 92
91. Ischnochiton pallidus Rve. Conch. Icon., . . . 89
92, 93. Ischnochiton petaloides Gld. U. S. Exped., . . 118
94, 95. Ischnochiton carinulatus Rv. Conch. Icon., . . 96
96, 97. Ischnochiton pallidulus Rv. Conch. Icon., . . 95

Plate 24.

98, 99. Ischnochiton crispus Rve. Conch. Icon., . . . 89
100, 1–4. Ischnochiton ustulatus Rve. Emerton del., . . 96
5. Chiton granulosus Frembly. Zool. Journ., . Appendix.
6. Liolophura curtisiana Smith. 'Alert' Zool., . . . 242
7, 8. Ischnochiton adelaidensis Rve. Conch. Icon., . . 136
9, 10. Ischnochiton muscarius Rve. Conch. Icon., . . 132
11, 12. Ischnochiton ustulatus Rve. Conch. Icon., . . 96
13–15. Ischnochiton tessellatus Q. & G. Astrol., . . 138
16, 17. Ischnochiton arbutum Rve. Conch. Icon., . . 139
18, 19. Ischnochiton milleri Gray. Conch. Icon., . . . 137
20–22. Ischnochiton cariosus Cpr. var. subcariosus Pils. Pilsbry del., ... 65, 67
23. Ischnochiton cariosus Cpr. typical. Emerton del., . . 65

Plate 25.

1–10. Ischnochiton dalli Haddon. Chall. Rep., . . . 133
11–19. Ischnochiton dorsuosus Haddon. Chall. Rep., . . 135

Plate 26.

20, 21. Ischnochiton mertensii Midd. Ross del., . . . 125
22, 24–26. Ischnochiton mertensii Midd. Pilsbry del., . 125
23. Ischnochiton mertensii Midd. Emerton, . . . 125
27. Ischnochiton cooperi Cpr. Ross del., ... 127
28–30. Ischnochiton cooperi Cpr. Pilsbry del., . . . 127
31–33. Ischnochiton clathratus Rve. Pilsbry del., . . 128
34. Ischnochiton clathratus Rve. Emerton del., . . . 128

Plate 27.

35–39. Ischnochiton lindholmi Schr. Amurl. Moll., . . 85
40–43. Ischnochiton cyaneopunctatus Kr. (=lentiginosus Sowb.) Südaf. Moll., ... 135
44. Ischnochiton lentiginosus Sowb. Conch. Ill., . . . 135
45, 46. Ischnochiton versicolor Sowb. Conch. Illustr., Appendix.
47, 48. Ischnochiton pulcherrimus Sowb. Conch. Icon., . 130
49. Ischnochiton constanti Velain. Arch. Z. Expér., Appendix.
50. Ischnochiton coreanicus A. & R. Conch. Icon., . . 129
51. Ischnochiton bergoti Velain. Arch. Z. Expér., Appendix.
52–54. Ischnochiton inca Orb. Voy. Amér. Mérid., Appendix.

Plate 28.

1–4. Chiton sulcatus Wood. Ross. del., ... 191
5–8. Chiton goodalli Brod. Ross. del., ... 191

Plate 29.

9. Chiton goodalli Brod. Conch. Icon., ... 191
10. Chiton barnesi Sowb. Conch Icon., ... 190
11, 12. Chiton barnesi Sowb. Pilsbry del., , . . . 190
13, 14. Chiton (?) dimorphus Rochebr. Miss. Cap Horn. (See appendix).
15–21. Chiton murrayi Haddon (?=C. pusio Sowb., p. 133). Chall. Rep., ... 161

Plate 30.

23. Chiton magnificus Desh. Ross del., ... 160
24. Chiton magnificus Desh. Emerton del., ... 160
25. Chiton stokesii Desh. Conch. Icon., ... 165
26. Chiton stokesii Desh. Original, ... 165
27. Chiton granosus Fremb. Pilsbry del., ... 167
28. Chiton granosus Fremb. Zool. Journ., ... 167
29, 31. Chiton cumingi Fremb. Conch. Icon., . . . 164
30. Chiton cumingi Fremb. Ross del., ... 164

Plate 31.

32–34. Chiton rusticus Desh. Moll. Réun., ... 186
35, 36. Chiton lyratus Sowb. Conch. Icon., ... 184
37, 38. Chiton angusticostatus Q. Voy. Astrol., . . . 187
39, 40. Chiton mauritianus Voy. Voy. Astrol., . . . 188
41, 42. Chiton capensis Gray (=nigrovirens Blv.). Conch. Icon., ... 187
43. Chiton cymbiola Sowb. (=tulipa Q.). Conch. Icon., . 185
44, 45, 47. Chiton tulipa Quoy. Ross del., ... 185
46. Chiton tulipa Quoy. Voy. Astrol., ... 185
48, 49. Chiton cymbiola Sowb. (=tulipa Q.) . . . 185

Plate 32.

50. Chiton patulus Brod. (=stokesii Brod,). Conch. Icon., 165
51–52. Chiton stokesii Brod. Pilsbry del., ... 165
53. Chiton stokesii Brod. (1 sq. mm. of girdle indicated), Pilsbry del., ... 165
54. Chiton virgulatus Sowb. Conch. Icon., ... 166
55, 56. Chiton virgulatus Sowb. Pilsbry del., . . . 166
57. Chiton albolineatus Sowb. Conch. Illustr., . . . 160

Plate 33.

58, 59, 60. Chiton tuberculatus L. Ross del., . . . 153
61. Chiton tuberculatus var. assimilis Rv. Conch. Icon., . 155
62. Chiton tuberculatus var. assimilis Rv. Ross del., . . 155
63. Chiton tuberculatus var. assimilis form ater. Ross del., 155
64. Chiton foveolatus Sowb.) (=viridis Spengl.). Conch. Icon., ... 156
65. Chiton viridis Spengl. Ross del., ... 156
66 67. Chiton viridis Spengl. Pilsbry del., ... 156

Plate 34.

68. Chiton lævigatus var. articulatus Sowb., ventral view. Emerton del., ... 159
69. Chiton lævigatus var. articulatus Sowb. Conch. Icon., . 159
70. Chiton lævigatus var. articulatus Sowb. interior. Pilsbry del., ... 159
71. Chiton lævigatus Sowb., typical. Conch. Icon., . . 159
72, 74. Chiton marmoratus Gmel. Ross del., . . . 158
73. Chiton marmoratus Gmel. Conch. Illustr., . . . 158
75. Chiton marmoratus Gmel., interior. Pilsbry del., . . 158
76. Chiton marmoratus Gmel. Conch. Icon., . . . 158
77–79. Chiton canariensis Orb. Moll. Canar., . . . 184

Plate 35.

80. Chiton marmoreus Rv. (=squamosus L.). Conch. Icon., 155
81. Chiton squamosus L., one-half valve. Pilsbry del., . 155

82. Chiton squamosus L. Ross del., ... 155
83, 84. Chiton insularis Rochebr. Nouv. Arch., ... 183
85, 86. Chiton hamyi Rochebr. Nouv. Arch., . . . 183
87, 88, 90. Chiton olivaceus Speng. Pilsbry del., . . 180
89, 91, 92. Chiton olivaceus Speng. Ross del., . . . 180
93. Chiton affinis Issel. Savigny, ... 181

Plate 36.

91. Chiton jugosus Gould. U. S. Exped., ... 178
92, 94, 95. Chiton jugosus Gould. Pilsbry del., . . . 178
93. Chiton jugosus Gould. Ross del., ... 178
96, 97. Chiton æreus Rve. Conch. Icon., ... 179
98, 99. Chiton marquesanus Pils. Pilsbry del., . . . 170
100. Chiton marquesanus Pils. Ross del., ... 170
1. Chiton sinclairi Gray. Erebus & Terror, . . . 174
2, 3. Chiton sinclairi Gray. Pilsbry del., ... 174
4, 6. Chiton canaliculatus Q. Pilsbry del., . . . 177
5. Chiton insculptus Ad. (=canaliculatus Q.). P. Z. S., . 177

Plate 37.

6. Chiton quoyi Desh. (color var.). Ross del., . . . 172
7. Chiton quoyi Desh. (sculpture) Pilsbry del., . . . 172
8. Chiton quoyi Desh. Conch. Icon., ... 172
9, 10. Chiton caliginosus Rve. Conch. Icon., . Appendix.
11. Chiton dissimilis Rve. Conch. Icon., ... 184
12, 13. Chiton muricatus Ad. P. Z. S., ... 175
14, 15. Chiton pellisserpentis Q. Ross del., . . . 173
16. Chiton pellisserpentis Q. Astrol., ... 173
17. Chiton pellisserpentis Q. (1 sq. mill. of the girdle indicated). Pilsbry del., ... 173
18. Chiton pellisserpentis Q. Emerton del., ... 173

Plate 38.

19. Chiton subfuscus Sowb. typical. Conch. Icon., . 162, 163
20. Chiton subfuscus var. mesoglyptus Pils. Conch. Ill., . 164
22. Chiton subfuscus var. mesoglyptus Pils. Ross del., . 164
21. Chiton subfuscus var. mesoglyptus, valve of same specimen as fig. 22. Pilsbry del., ... 164
23. Chiton bowenii King. Conch. Illustr., ... 164
24–26. Ischnochiton sulcatus Q. & G. Voy. Astrol., . . 138
27, 28. Chiton tenuistriatus Sowb. Conch. Ill., . . . 188
29, 30. Chiton cingillatus Rve. Conch. Icon., . Appendix.
31, 32. Chiton luzonicus Rve. Conch. Icon., . Appendix.
33, 34. Chiton aquatilis Rve. Conch. Icon., . . . 169

Plate 39.

35. Tonicia disjuncta Fremb. Conch. Icon., ... 212

36–41. Tonicia disjuncta Fremb. Emerton del., . . . 212
42–51. Craspedochiton laqueatus Shutt. Emerton del., . 285
52. Ischnochiton rugulatus Sowb var. Conch. Icon., . . 110

Plate 40.

1, 2. Tonicia truncata Sowb. Conch. Icon., . . . 211
3, 4. Tonicia fortilirata Sowb. Conch. Icon., . . . 207
5, 6. Tonicia picta Sowb. Conch. Icon., ... 211
7. Tonicia carpenteri Angas. P. Z. S., ... 208
8–11. Tonicia lamellosa Q. & G. Voy. Astrol., . . . 209
12. Tonicia zschaui Pfr. Moll. S. Georg., ... 204
13–15. Tonicia tehuelchus Orb. Voy. Amér. Mérid., . . 205
16, 17. Tonicia suezensis Rve. Conch. Icon., . . . 206

Plate 41.

19. Tonicia chilensis Fremb. Pilsbry del., ... 197
20. Tonicia chilensis Fremb. Conch. Icon., ... 197
21. Tonicia fastigiata Sowb. Pilsbry del., ... 199
22. Tonicia elegans Fremb. Pilsbry del., ... 196
Betw. 22 and 24. Tonicia elegans Fremb. (color-pattern only). Pilsbry del., ... 196
24. Tonicia elegans Fremb. (second valve). Pilsbry del., . 196
25. Tonicia lineolata Fremb. Conch. Icon., ... 198
26. Tonicia lineolata Fremb. Zool. Journ., ... 198
27. Tonicia lineolata (var. connecting with elegans). Ross del., ... 198
28. Tonicia atrata Sowb. Conch. Ill., ... 201
29, 30. Tonicia atrata Sowb. Conch., Icon., . . . 201

Plate 42.

31. Tonicia elegans Fremb. Ross del., ... 196
32. Tonicia elegans Fremb. var. Conch. Icon., . . . 196
33, 34, 35. Tonicia elegans Fremb. (not typical). Emerton, del., ... 196
36–39. Tonicia fastigiata Gray. Conch. Icon, . . . 199
40. Tonicia chilœnsis (=fastigiata). Conch. Icon., . . 199

Plate 43.

41. Tonicia swainsoni Sowb. Conch. Icon., ... 201
42. Tonicia swainsoni Sowb. Pilsbry del., ... 201
43. Tonicia swainsoni Sowb. Ross del., ... 201
44, 45. Tonicia granifera Sowb. Conch. Icon., . . . 200
46, 47. Tonicia grayi Sowb. Conch. Icon., ... 200
48, 49. Tonicia (?) martıeli Rochebr. Moll. Cap Horn, . 203
50, 51. Tonicia horniana Rochebr. Moll. Cap Horn, . . 203
52, 53. Tonicia lebruni Rochebr. Moll. Cap. Horn, . . 203

54, 55. Tonicia schrammi Shuttlew. Pilsbry del., . . 205
56. Tonicia schrammi Shuttlew. Journ de Conch., . . 205

Plate 44.

57, 60. Chætopleura watsoni Sowb. Conch. Icon., See appendix.
58, 59. Chætopleura watsoni Sowb. Conch. Ill., See appendix.
61. Chætopleura castanea Q. Voy. Astrol., . See appendix.
62. Chætopleura fulva Wood. Ross. del., . . See appendix.
63. Chætopleura fulva Wood. Conch. Icon., . See appendix.
64. Chætopleura fulva Wood. Pilsbry del., . . See appendix.
65, 67. Tonicia rubridens Pils. Pilsbry del., . . . 202
66. Tonicia rubridens Pils. Ross del., ... 202
68. Craspedochiton laqueatus Sowb. Conch. Icon., . . 285

Plate 45.

69, 70. Tonicia crenulata Sowb. Conch. Icon., . . . 195
71, 72. Tonicia crenulata Sowb. Ross del., ... 195
73. Chiton rubicundus Costa. Catal., ... 182
74, 75. Chiton pulchellus Phil. (=rubicundus Costa). Enum., 182
76, 77. Acanthopleura borbonica Dh. Pilsbry del., . . 230
78, 79. Acanthopleura borbonica Dh. Moll. Réun., . . 230
80, 81, 83, 84. Acanthopleura spinosa Brug. (valves i, ii, viii). Emerton del., ... 220
82, 87. Acanthopleura spinosa Brug. (valve iv). Pilsbry del., 220
85. Acanthopleura spinosa Brug. Conch. Icon., . . . 220
86. Acanthopleura spinosa Brug. (girdle spines). Emerton del., ... 220

Plate 46.

88. Eudoxochiton nobilis Gray (type). Erebus & Terror, . 193
89, 90. Eudoxochiton nobilis Gray (valve vii). Pilsbry del., 193
91. Eudoxochiton nobilis Gray (interior). Emerton del., . 193
92–94. Eudoxochiton nobilis Gray (valve viii). Pilsbry del., 193
95. Eudoxochiton nobilis Gray. Pilsbry del., . . . 193
96, 100. Eudoxochiton huttoni Pils. (valve vii). Pilsbry del., 194
97. Eudoxochiton huttoni Pils. Ross del., ... 194
98, 99. Eudoxochiton huttoni Pils. (valve viii). Pilsbry del., 194
1–5. Chiton miles Cpr. Emerton del., ... 188

Plate 47.

6–9, 11–14. Acanthopleura echinatum Barnes. Emerton del., ... 218
10. Acanthopleura echinatum Barnes. Zool. Journ., . . 218
15–17. Acanthopleura echinatum (young). Emerton del., . 218
18–20. Acanthopleura brevispinosa Sowb. Emerton del., . 231
21. Acanthopleura brevispinosa Sowb. Ross del., . . 231

Plate 48.

22. Acanthopleura spiniger Sowb. Charlesworth's Mag. Nat. Hist., ... 221
23. Acanthopleura spiniger Sowb. Conch. Illustr., . . 221
24–26. Acanthopleura spiniger Sowb. (Interior, and posterior valve). Pilsbry del., ... 221
27. Acanthopleura spiniger Sowb. Conch. Icon., . . 221
28. Acanthopleura spiniger var. granata Rv. Pilsbry del., 224, [225
29, 30. Acanthopleura spiniger var. granata Rv. Conch. Icon., ... 224, 225
31. Acanthopleura spiniger var. (Viti Is.) Ross del., . . 223
32. Acanthopleura spiniger var. (Viti Is.). Pilsbry del., . 223

Plate 49.

33, 34. Acanthopleura spiniger var. cunninghami Rve. Conch. Icon., ... 225
35, 36. Chiton linter (Chemn.) Rve. Conch. Icon., (See appendix.)
37, 38. Chiton piceus Rv. not Linn. (=A. spiniger var. obesa Shuttl.). 226

Plate 50.

39. Acanthopleura granulata Gmel. (St. Thomas). Ross del., 227
40, 41. Acanthopleura granulata Gmel. (group of white and of dark spines). Pilsbry del., ... 227
42. Acanthopleura granulata Gmel. (occidentalis Reeve). Conch. Icon., ... 227
43. Acanthopleura granulata (Key Vaccas, Fla.). Ross del., 227
44–47. Acanthopleura granulata Gmel. (St. Domingo). Pilsbry del., ... 227
48. Acanthopleura granulata Gmel. (St. Thomas). Ross del., 227
49. Acanthopleura granulata Gmel. Emerton del., . . 227

Plate 51.

1. Schizochiton incisus Sowb. 235
2. Schizochiton incisus Sowb. (half of head valve). Q. J. M. S., ... 235
3. Schizochiton incisus Sowb. (eye, x 200). Q. J. M. S., . 235
4–5. Schizochiton incisus Sowb. (valves i and ii). Emerton del., ... 235
6–8. Schizochiton incisus Sowb. (valve viii, ventral, profile and posterior views). Emerton del., ... 235
9–12. Lorica angasi Ad. & Ang. Emerton del., . . . 238

Plate 52.

14. Lorica cimolea Rv. (=volvox Rve.). Conch. Icon., . 237
15. Lorica volvox Rve. Ross del., ... 237
16. Lorica volvox Rv. (1 sq. mill. of girdle). Pilsbry del., . 237
17, 18. Lorica volvox Rv. (posterior valve). Pilsbry del., . 237
19. Lorica volvox Rv. (anterior valve). Pilsbry del., . . 237
20, 21. Lorica volvox Rv. (intermediate valve). Pilsbry del., 237
22, 23. Enoplochiton niger Barnes (posterior valve). Emerton del., ... 252
24, 25. Enoplochiton niger Barnes (intermediate valve). Pilsbry del., ... 252
26. Enoplochiton niger Barnes. Ross del., ... 252
27. Enoplochiton niger (surface). Q. J. M. S., . . . 252
28. Enoplochiton niger (surface). Q. J. M. S., . . . 252
29. Enoplochiton niger (girdle of a young specimen). Emerton del., ... 252

Plate 53.

30. Liolophura incana Gld. (=L. gaimardi Blv.). U. S. Expl. Exped., ... 240
31. Liolophura gaimardi Blv. (girdle spines). Pilsbry del., . 240
32. Liolophura gaimardi Blv. Ross del., ... 240
33–35. Liolophura gaimardi Blv. Pilsbry del., . . . 240
36–40. Liolophura georgiana Q. & G. Voy. Astrol., . . 241
41. Liolophura japonica Lisch. (Girdle spines). Pilsbry del., 242
42. Liolophura japonica Lisch. Ross del., ... 242
43, 44. Liolophura japonica Lisch. Jap. Meeres-Conch., . 242
45. Liolophura japonica var. tessellata Pils. Ross del., . 243
46. Liolophura japonica var. tessellata Pils. Pilsbry del., . 243

Plate 54.

21, 22. Nuttallina scabra Rv. Pilsbry del., ... 280
23, 24. Nuttallina californica Nutt. Pilsbry del., . . 279
25–27. Nuttallina alternata Sowb. Conch. Ill., . . . 281
28–30. Nuttallina cinerea Poli. Emerton del., . . . 283
31. Nuttallina cinerea Poli (edge of girdle x 100). Pilsbry del., ... 283
32. Nuttallina cinerea Poli. Test. Utr. Sic., ... 283
33. Nuttallina cinerea Poli (girdle x 50 ca.) Pilsbry del., . 283
34, 35. Plaxiphora ovata Hutt. Pilsbry del., . . . 332
36–39. Plaxiphora ovata Hutt. (profile, posterior, dorsal and ventral views of posterior valve). Pilsbry del., . . 332
40. Plaxiphora ovata Hutt. (sculpture of intermediate valves). Pilsbry del., ... 332
41–45. O. caliginosus Cpr. (=Liolophura japonica Lisch.) Emerton del., ... 244
46. Onithochiton amicorum Bd. Voy. Curacoa, . . . 249

Plate 55.

1. Onithochiton lyellii Sowb. Conch. Illustr., . . . 247
2. Onithochiton lyellii Sowb. Conch. Icon., . . . 247
3–7. Onithochiton lyellii Sowb. Emerton del., . . . 247
8, 9. Onithochiton incii Rv. (=lyellii Sowb.). Conch. Icon., 248
10, 11. Onithochiton semisculptus Pils. Ross del., . . 247
12, 13. Onithochiton quercinus Gld. U. S. Exped., . . 248
14, 15. Onithochiton undulatus Q. & G. Ross del., . . 245
16. Onithochiton undulatus Q. & G. Voy. Astrol., . . 245
17, 18. Plaxiphora wahlbergi Kr. Südaf. Moll., . . . 322
19. Onithochiton rugulosus Ang. P. Z. S., ... 249
20. Onithochiton maillardi Desh. Moll. Réun., . . . 250
21-23. Onithochiton literatus Kr. Südafrik. Moll., . . 251

Plate 56.

1, 4, 6. Pallochiton lanuginosus Cpr. Ross del., . . 257
2, 3. Pallochiton lanuginosus Cpr. Pilsbry del., . . 257
5, 7–11. Pallochiton lanuginosus Cpr. Emerton del., . . 257
12–16. Nuttallina californica Nutt. Emerton del., . . 279
17, 18. Nuttallina californica Nutt. Ross del., . . . 279
19, 20. Nuttallina scabra Rve. Ross del., ... 280

Plate 57.

21. Dinoplax gigas Gmel. Conch. Icon., ... 255
22, 27–31. Dinoplax gigas Gmel. Emerton del., . . . 255
23–26. Dinoplax gigas Gmel. (young). Südafrik. Moll., . 255
32. Dinoplax gigas Gmel. (young). Ross del., . . . 255
33, 35. Tonicia confossa Gld. Pilsbry del., ... 210
34. Tonicia confossa Gld. U. S. Expl. Exped., . . . 210

Plate 58.

1, 2. Callistochiton crassicostatus Pils. Emerton del., . . 264
3–6. Callistochiton crassicostatus Pils. Pilsbry del., . . 264
Fig. below 1, and 7, 8. Callistochiton palmulatus Cpr. Emerton del., ... 262
9–11. Callistochiton palmulatus var. mirabilis Pils. Pilsbry del., ... 263
12. Callistochiton palmulatus (typical). Pilsbry del., . . 262
13–16. Callistochiton palmulatus (typical). Emerton del., . 262
17. Callistochiton decoratus Cpr. Ross del., . . . 269
18–20. Callistochiton decoratus Cpr. Pilsbry del., . . 269
21, 22. Plaxiphora cælata Rve. Conch. Icon., . . . 328

Plate 59

21–26. Callistochiton pulchrior Cpr. (=pulchellus Gray). Foord del., ... 272

27, 28. Callistochiton elenensis Sowb. Conch. Ill., . . 267
29, 34. Callistochiton antiquus Rv. Pilsbry del., . . . 274
30–32. Callistochiton antiquus Rv. Emerton del., . . 274
35. Callistochiton antiquus Rv. Conch. Icon., . . . 274
36. Callistochiton coppingeri Sm. 'Alert' Zool., . . . 275
37–42. Callistochiton infortunatus Pils. Foord, del., . . 266
43, 44. Callistochiton bicostatus Orb. (=pulchellus Gray). Voy. Am. Mér., ... 272
45. Callistochiton adenensis Smith. P. Z. S., . . . 276

Plate 60.

1. Callistochiton pulchellus Gray. Spicil. Zool., . . . 271
2. Callistochiton pulchellus Gray. Conch. Icon., . . 271
3–6. Callistochiton pulchellus Gray. Pilsbry del., . . 271
7–10. Callistochiton gabbi Pils. Pilsbry del., . . . 270
11–15. Callistochiton (?) heterodon Pils., ... 276
16. Callistochiton (?) heterodon var. savignyi Pils. Savig. Ægypt, ... 277

Plate 61.

17–22. Callistoplax retusus Sowb. Emerton del., . . 288
23, 24. Callistoplax retusus Sowb. Emerton del., . . . 288
25. Callistoplax retusus Sowb. Conch. Illustr., . . . 288
26. Callistoplax retusus Sowb. Conch. Icon., . . . 288
27–32. Angasia tetrica Cpr. Emerton del., ... 287
33. Ceratozona rugosa Sowb. Conch. Ill., ... 290
34. Ceratozona rugosa Sowb. (Santa Cruz). Pilsbry del., . 290
35. Ceratozona rugosa Sowb. Pilsbry del., ... 290
36. Ceratozona rugosa Sowb. (Jupiter Inlet). Pilsbry del, . 290
37. Ceratozona guildingii Rv. (=rugosa Sowb.) Conch. Icon., ... 290
38, 39. Ceratozona setosa Sowb. Emerton del., . . . 292
40. Ceratozona setosa Sowb. Conch. Ill., ... 292
41–45. Ceratozona rugosa Sowb. Emerton del., . . . 290

Plate 62.

84, 85. Placiphorella stimpsoni Gld. (tail valve). Pilsbry del., 307
86. Placiphorella stimpsoni Gld. (girdle-hair). Carpenter del., 307
87. Placiphorella stimpsoni Gld. Ross del., . . . 307
88–92. Mopalia middendorffii Schr. Amurl. Moll., . . 301
93. Mopalia muscosa var. porifera Pils. Pilsbry del., . . 297
94. Mopalia muscosa var. porifera Pils. Ross del., . . 297
95. Mopalia sinuata Cpr. (girdle). Emerton del., . . 303
96 (upper fig.). Mopalia sinuata Cpr. Ross del., . . 303
96 (lower three figs.). Mopalia sinuata Cpr. (tail valve). Emerton del., ... 303

97. Mopalia sinuata Cpr. (intermediate valve). Pilsbry del., 303
98. Mopalia imporcata Cpr. (intermediate valve). Pilsbry del., ... 301
99. Mopalia muscosa var. hindsii Bd. Pilsbry del., . . 296
100. Mopalia muscosa var. hindsii Bd. Ross del., . . . 296

Plate 63.

46. Mopalia muscosa Gld. (typical). U. S. Expl. Exped., . 295
47, 48. Mopalia muscosa Gld. Ross del., ... 295
49–56. Mopalia muscosa Gld. Emerton del., . . . 295
57. Mopalia muscosa var. hindsii Bd. Conch. Icon., . . 296
58, 59. Mopalia lignosa Gld. Ross del., ... 299
60. Mopalia lignosa smooth form. Ross del., . . . 300
61. Mopalia lignosa smooth form. Pilsbry del., . . . 300
62. Mopalia lignosa (vespertina Gld.). U. S. Ex. Exped., . 300
63. Mopalia insignis Newc. (=lignosa Gld.) 300

Plate 64.

64–68. Mopalia ciliata Sowb. (Monterey Bay). Ross & Pilsbry del., ... 303
69, 70, 71. Mopalia ciliata var. wosnessenkii Midd. Mal. Ross. 305
72. Mopalia ciliata var. wosnessenskii Midd. Pilsbry del., . 305
73. Mopalia ciliata var. wosnessenskii Midd. Ross del., . 305
74. Mopalia muscosa Gld. Emerton del., ... 295
75. Mopalia acuta Cpr. Ross del., ... 297
76–79. Mopalia acuta Cpr. (tail valves). Pilsbry del., . . 297
80, 81. Mopalia plumosa Cpr. (=acuta Cpr.). Foord del., . 298
82, 83. Mopalia lignosa form elevata. Ross del., . . . 300

Plate 65.

73–75. Plaxiphora atlantica V. (tail valve). Pilsbry del., . 313
76. Plaxiphora setiger King. Conch. Icon., . . . 316
77, 78, 79. Plaxiphora setiger King. Emerton & Ross del., 316
80–82. Plaxiphora egregia Ad. P. Z. S., . . . 331

Plate 66.

6, 7. Placiphorella velata Cpr. Emerton del., . . . 306
8–10. Placiphorella velata Cpr. (posterior valve). Pilsbry del., ... 306
11. Placiphorella velata Cpr. (intermediate valve). Pilsbry del., ... 306
12. Placiphorella velata (Insertion-plate, seen from end of valve). Pilsbry del., ... 306
13. Placiphorella velata (girdle-hair). Pilsbry del., . . 306
14. Placiphorella borealis Pils. (intermed. valve). Pilsbry del., 309

15. Placiphorella borealis Pils. (Insertion-plate seen from end of valve). Pilsbry del., ... 309
16, 17. Placiphorella borealis Pils. (posterior valve). Pilsbry del., ... 309
18–24. Placophoropsis atlantica V. Tr. Conn. Acad., . . 313
25. Placiphorella petasus Rv. Conch. Icon., . . . 311
26, 27. Placiphorella blainvillii Sowb. Conch. Icon., . . 310
28–32. Placiphorella blainvillii Sowb. Emerton del., . . 310

Plate 67.

33–36. Plaxiphora carpenteri Had. Chall. Rep., . . 325
37, 38. Chætopleura hahni Rochebr. (=Plaxiphora fremblyi) Miss. Cap Horn, ... 318
39, 40. Chætopleura frigida Rochebr. (=Plaxiphora setiger, young). Miss. Cap Horn, ... 317
41, 42. Chætopleura savatieri Rochebr. (=Plaxiphora setiger) Miss. Cap Horn, ... 317
43–46. Plaxiphora simplex Cpr. Chall. Rep., . . . 320

Plate 68.

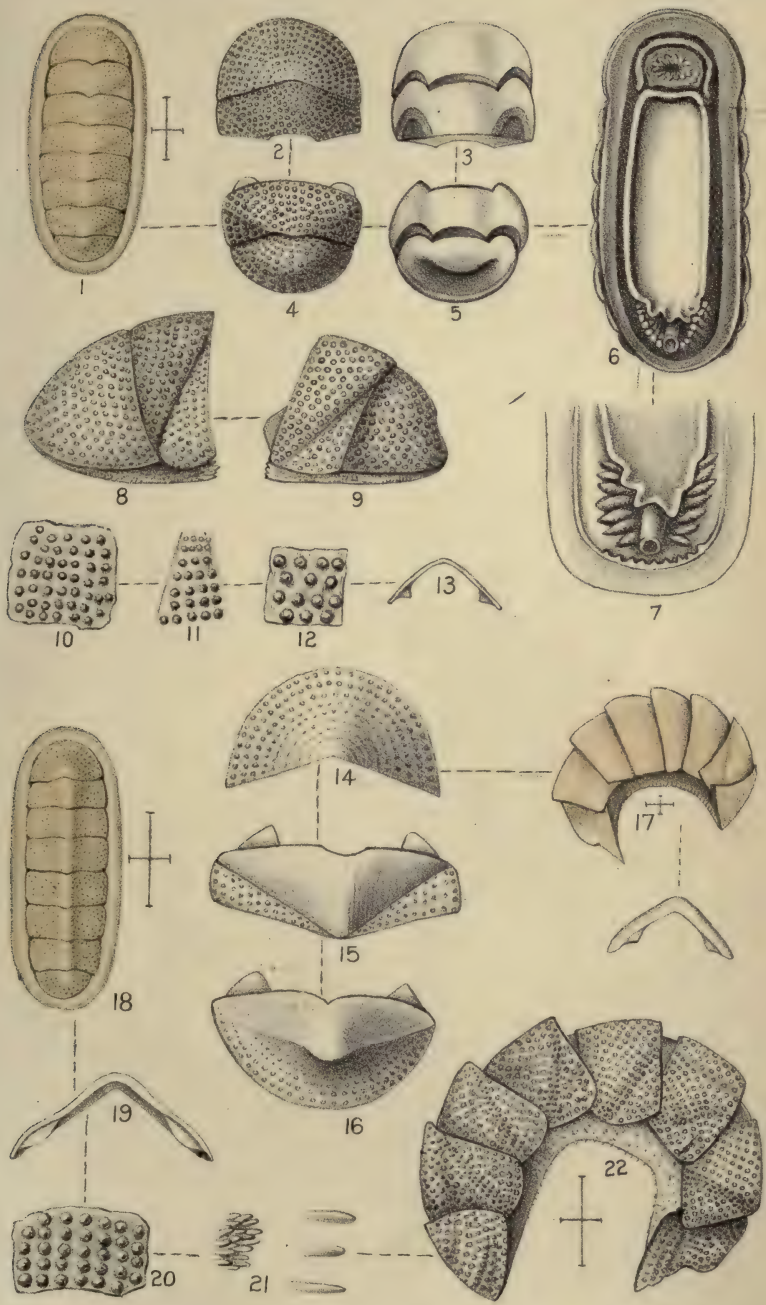
51–54. Plaxiphora biramosa Q. & G., Voy. Astrol., . . 319
55–61. Plaxiphora superba Cpr. (=biramosa Q.). Emerton del. 319
62, 64. Plaxiphora petholata Sowb. Pilsbry del., . . 323
63, 66. Plaxiphora petholata Sowb. Emerton del., . . 323
65. Plaxiphora petholata Sowb. Ross. del., . . . 323
67. Plaxiphora petholata Sowb. Conch. Illustr., . . . 323
68–72. Plaxiphora glauca Q. & G. Voy. Astrol., . . 326

Note.—The Parts of Vol. XIV of the Manual were issued to subscribers upon the following dates:

Part 53, including pp. 1– 64, plates 1–15, July 25, 1892,
Part 54, " " 65–128, " 16–30, Nov. 25, 1892.
Part 55, " " 129–208, " 31–40, Feb. 25, 1893.
Part 56, " " 209–350, " 41–68, June, 1893.

The Title page, Preface and Introduction to *Polyplacophora*, accompany Part 56.

End of Vol. XIV.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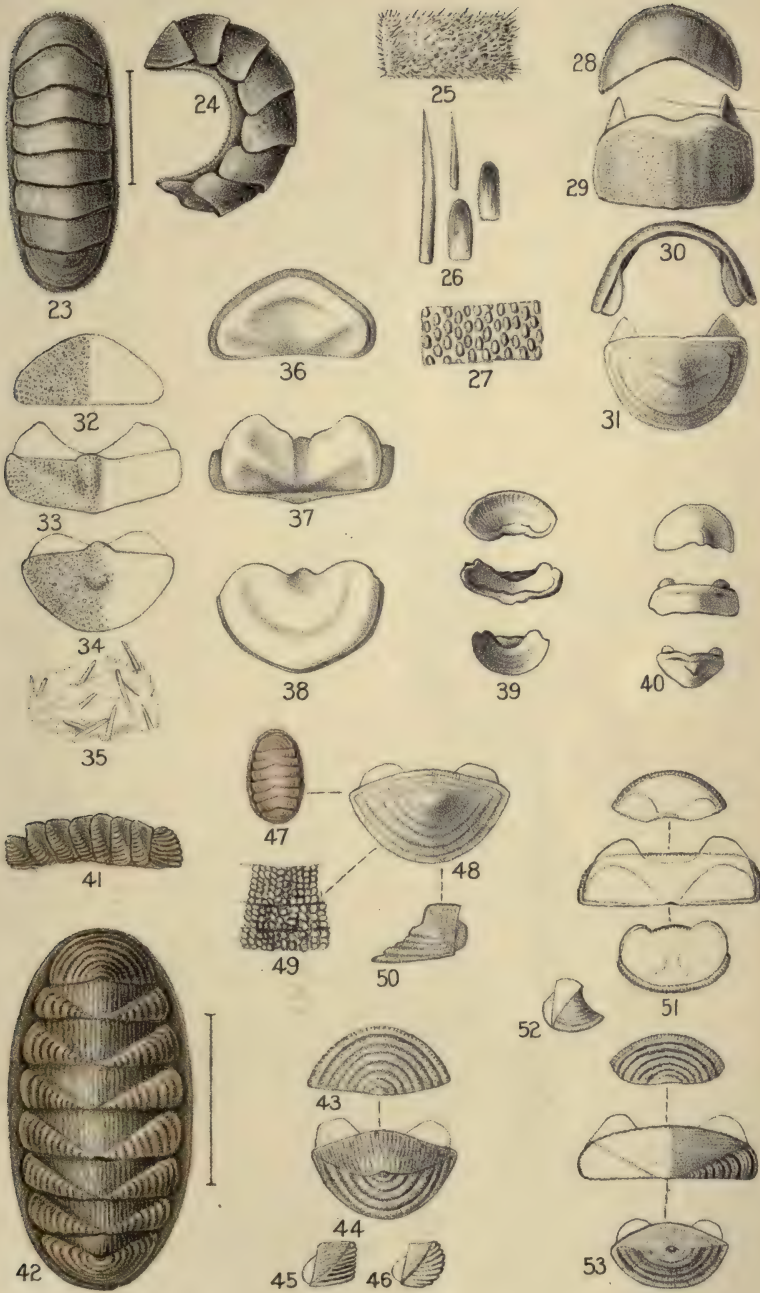
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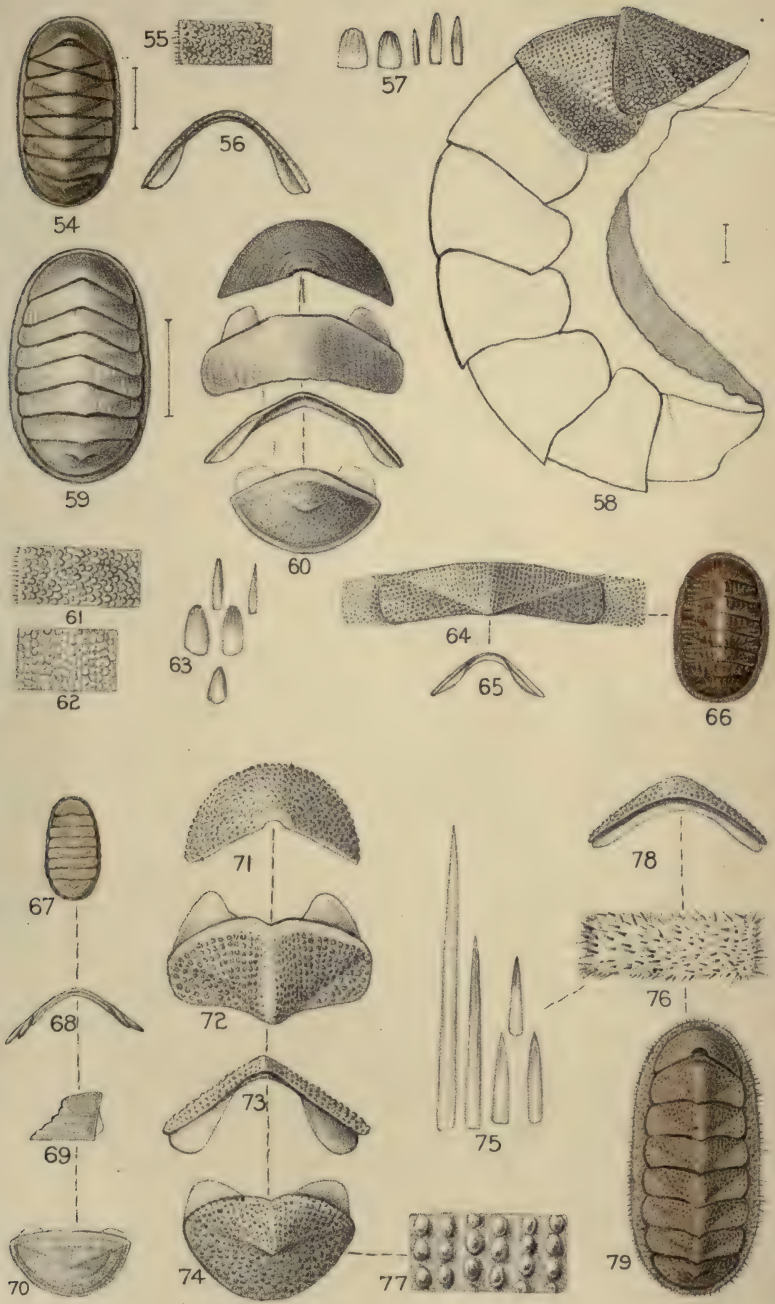
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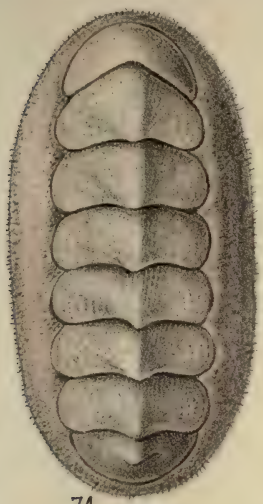
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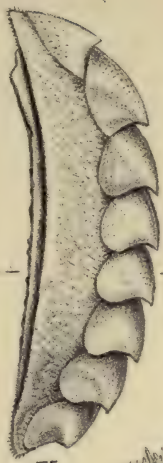
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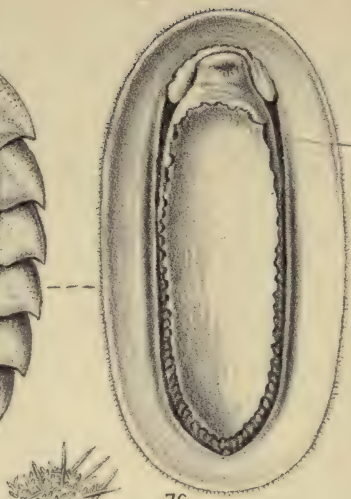
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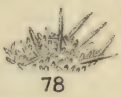
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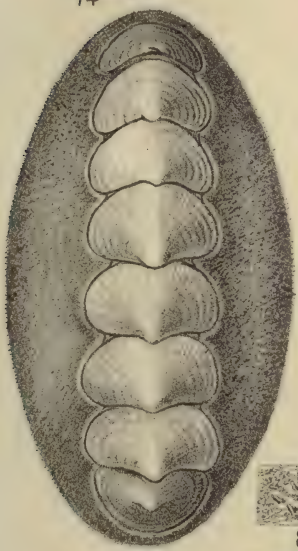
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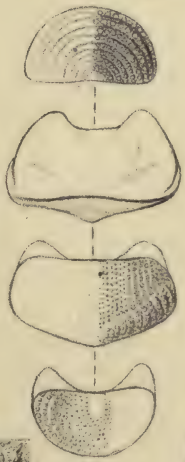
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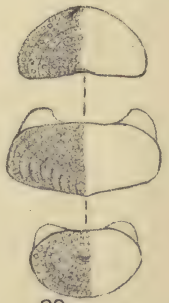
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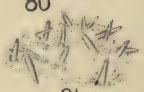
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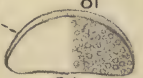
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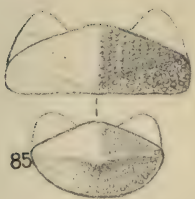
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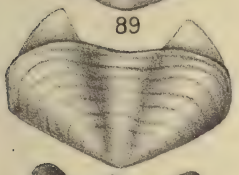
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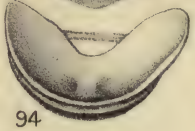
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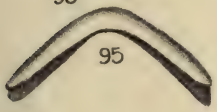
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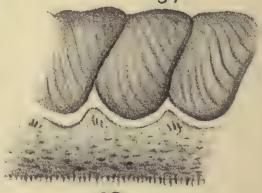
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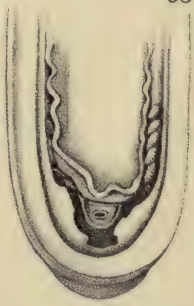
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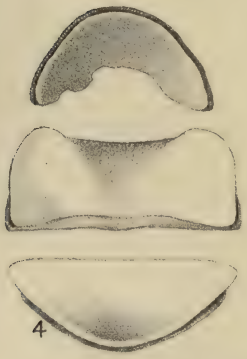
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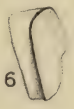
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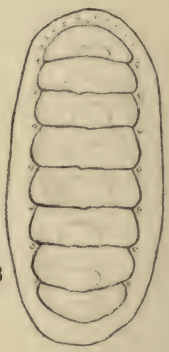
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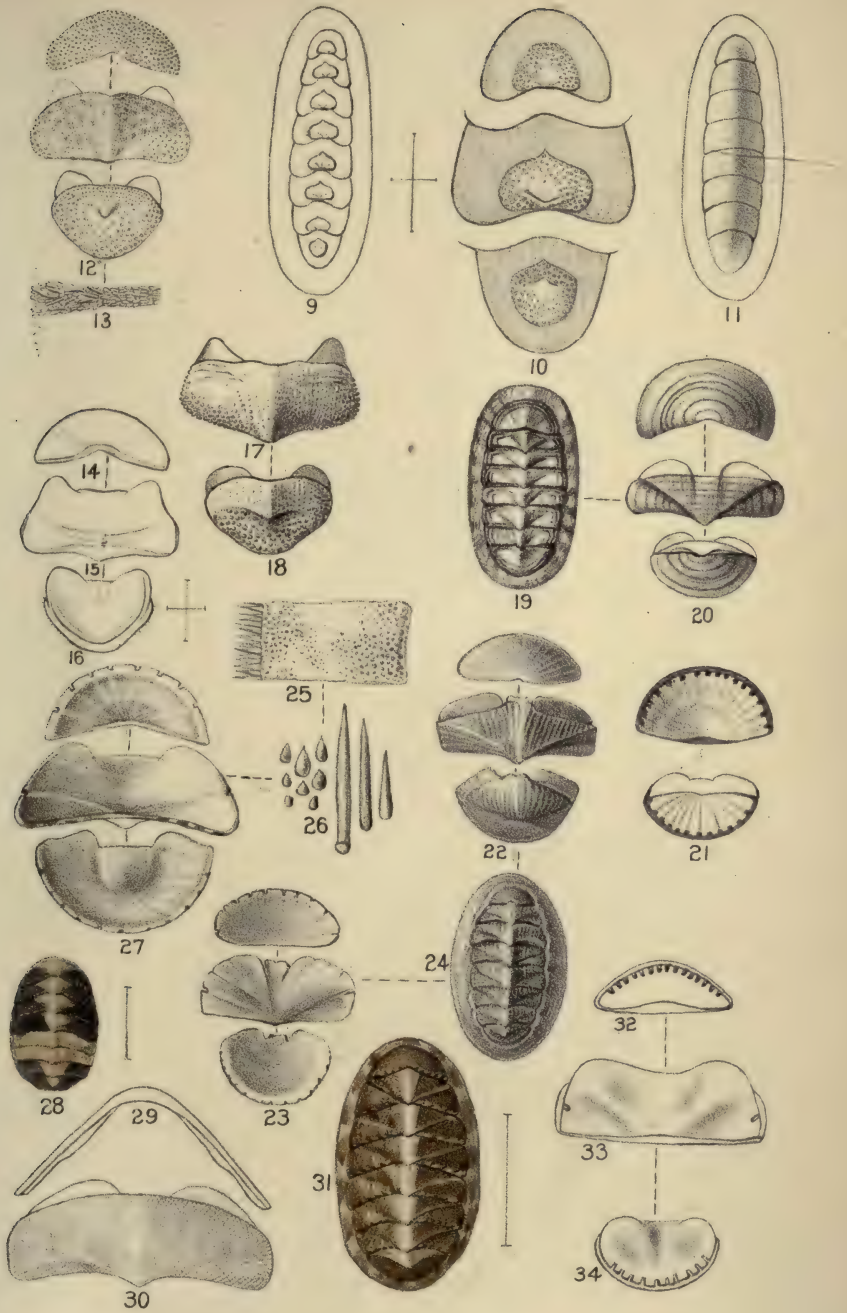
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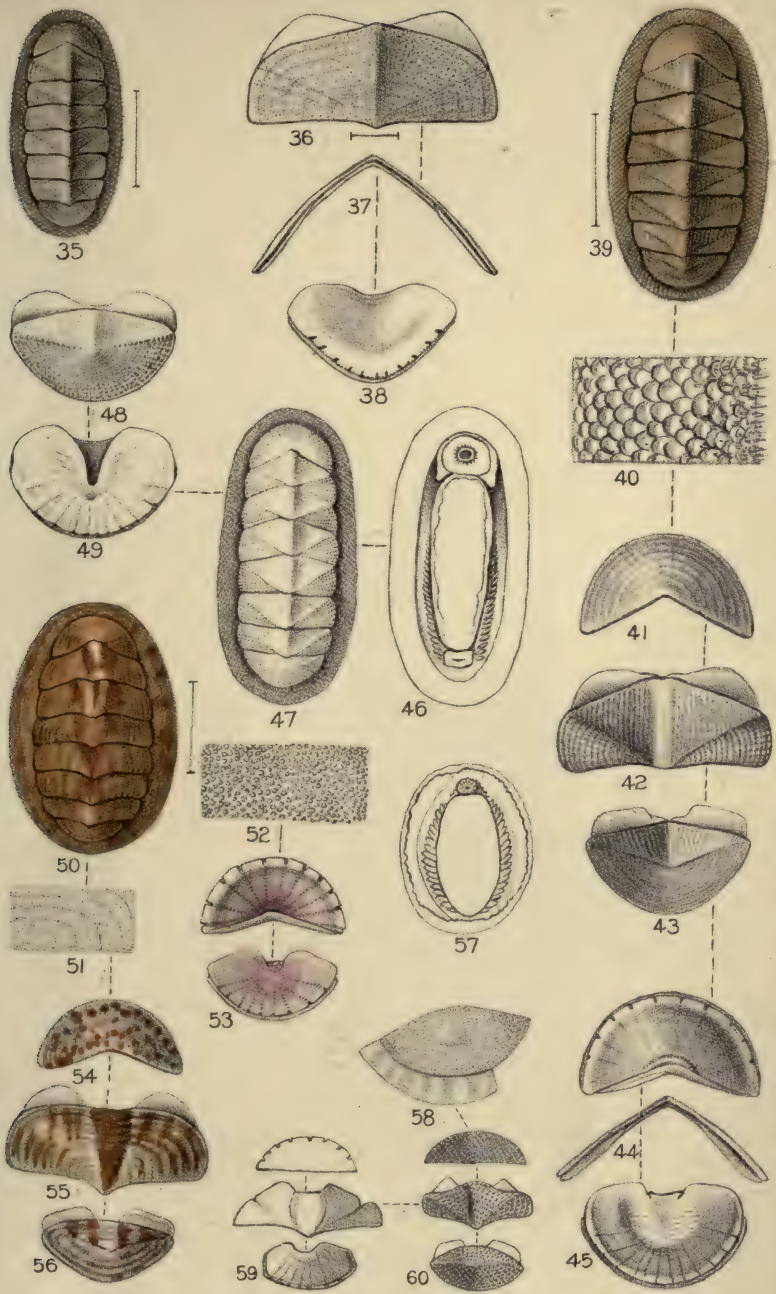
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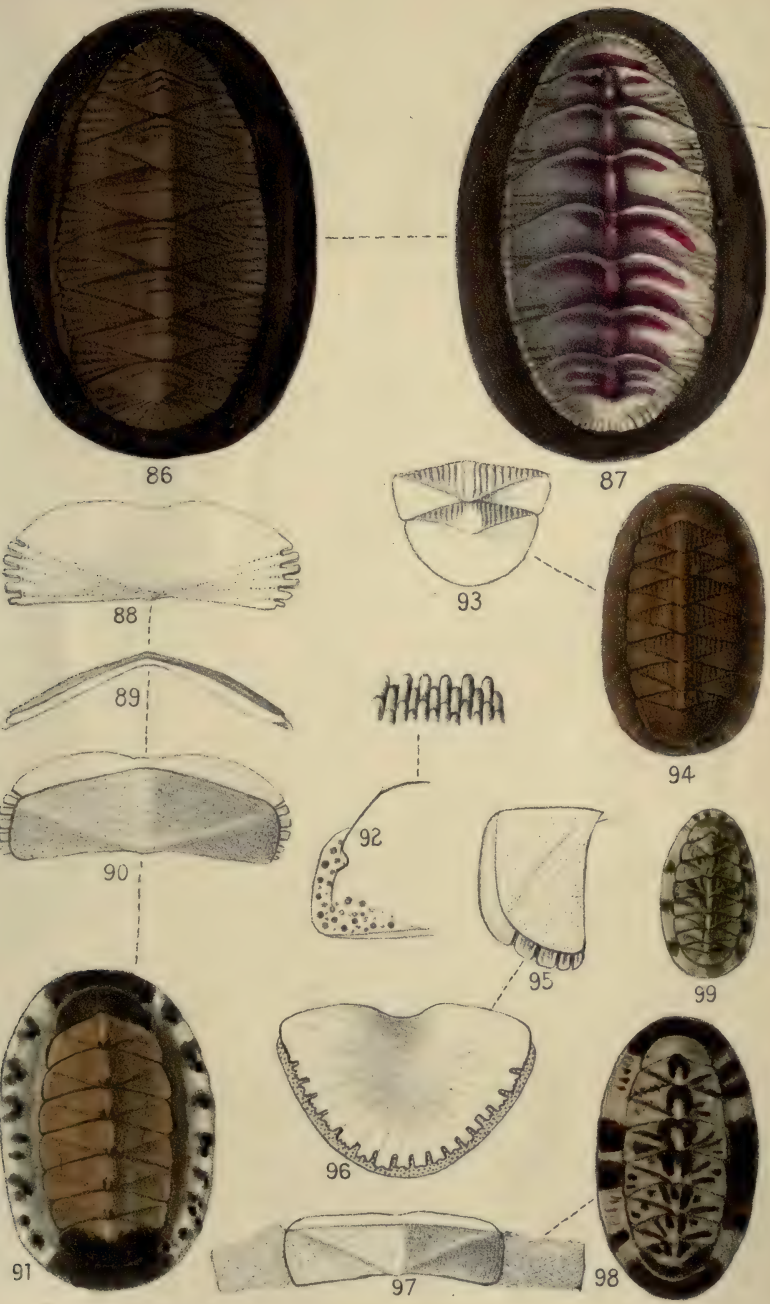
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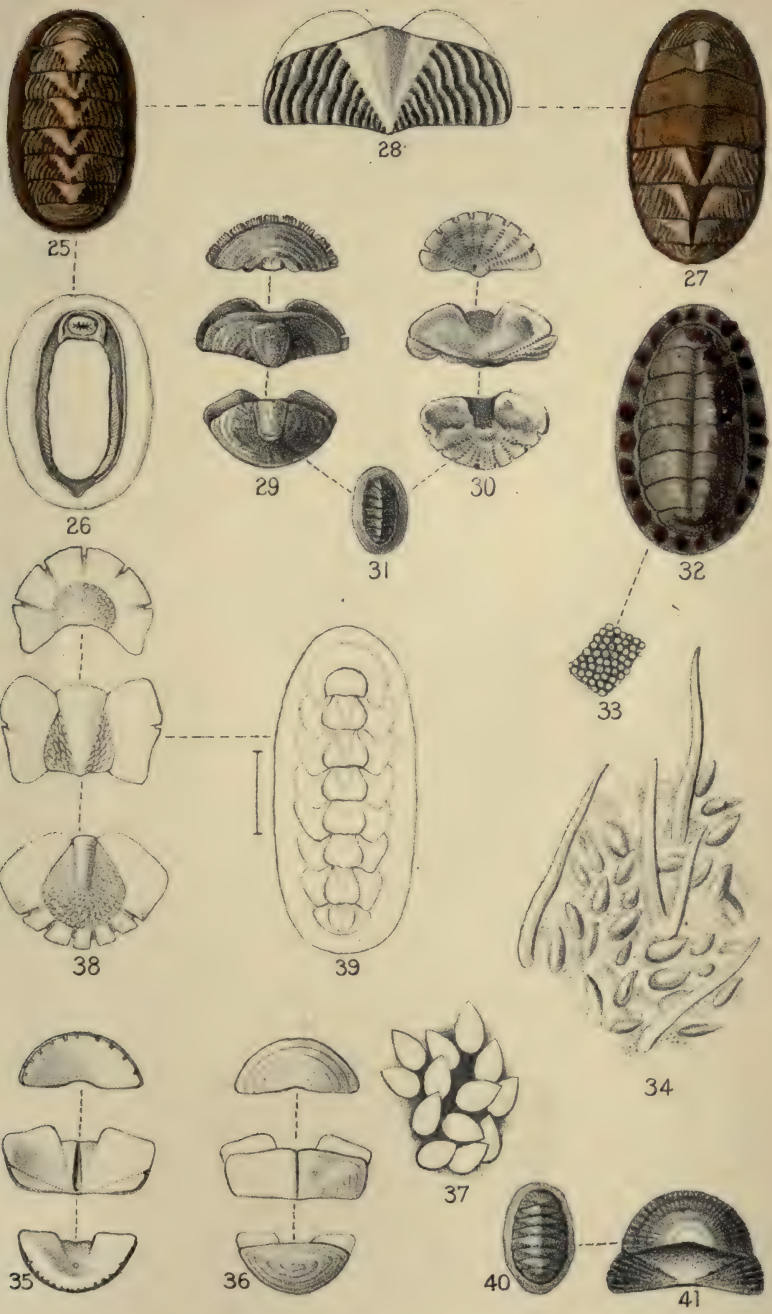
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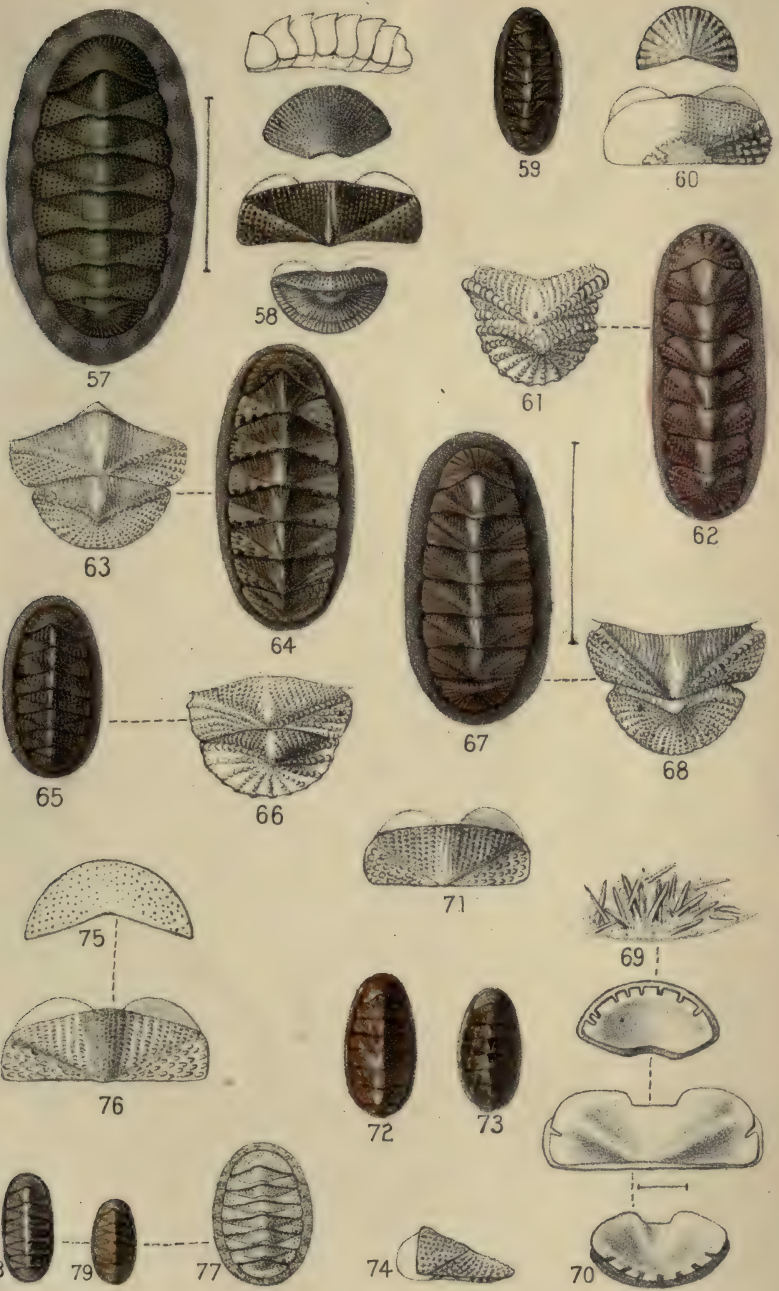
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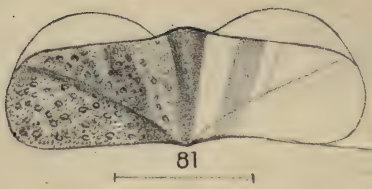

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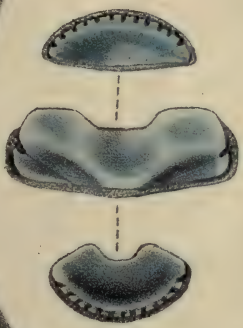

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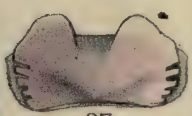

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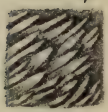

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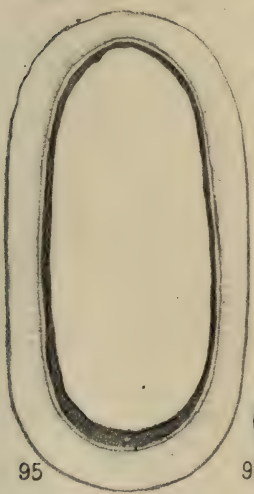

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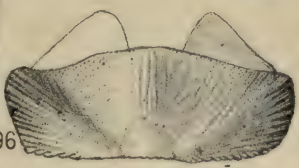

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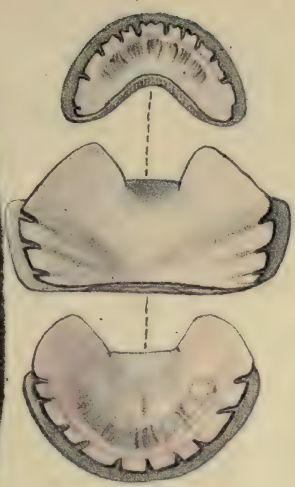

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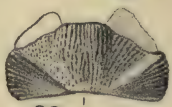

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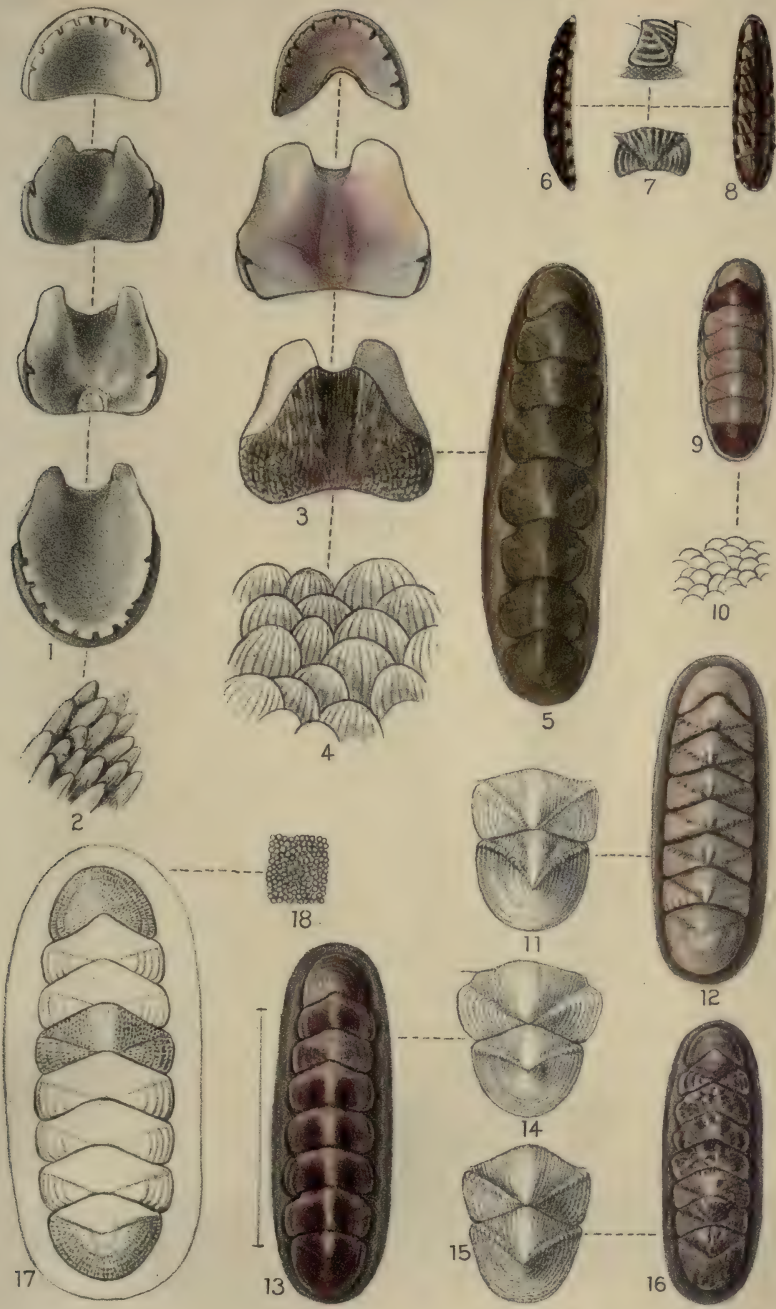
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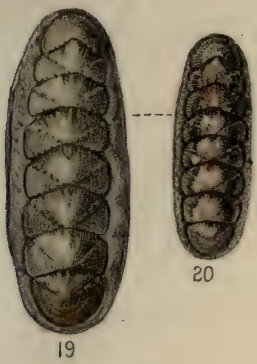
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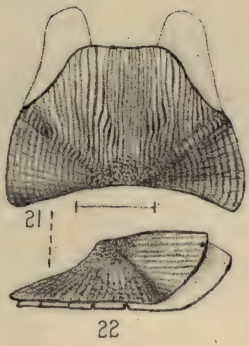
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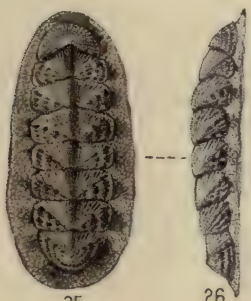
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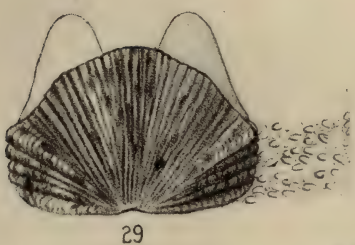
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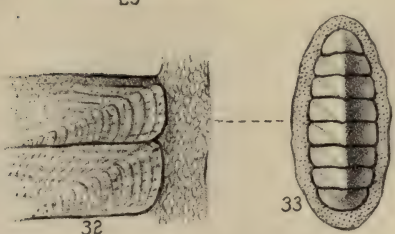
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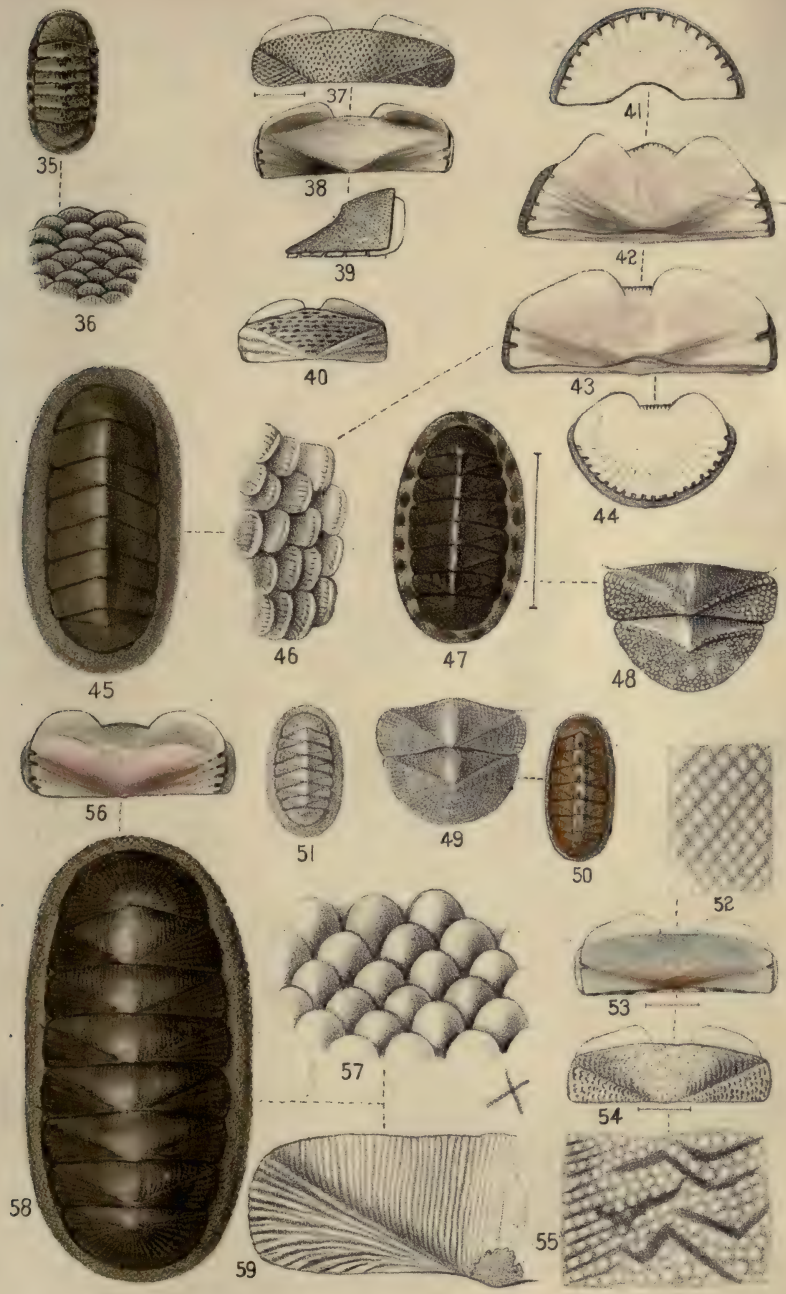
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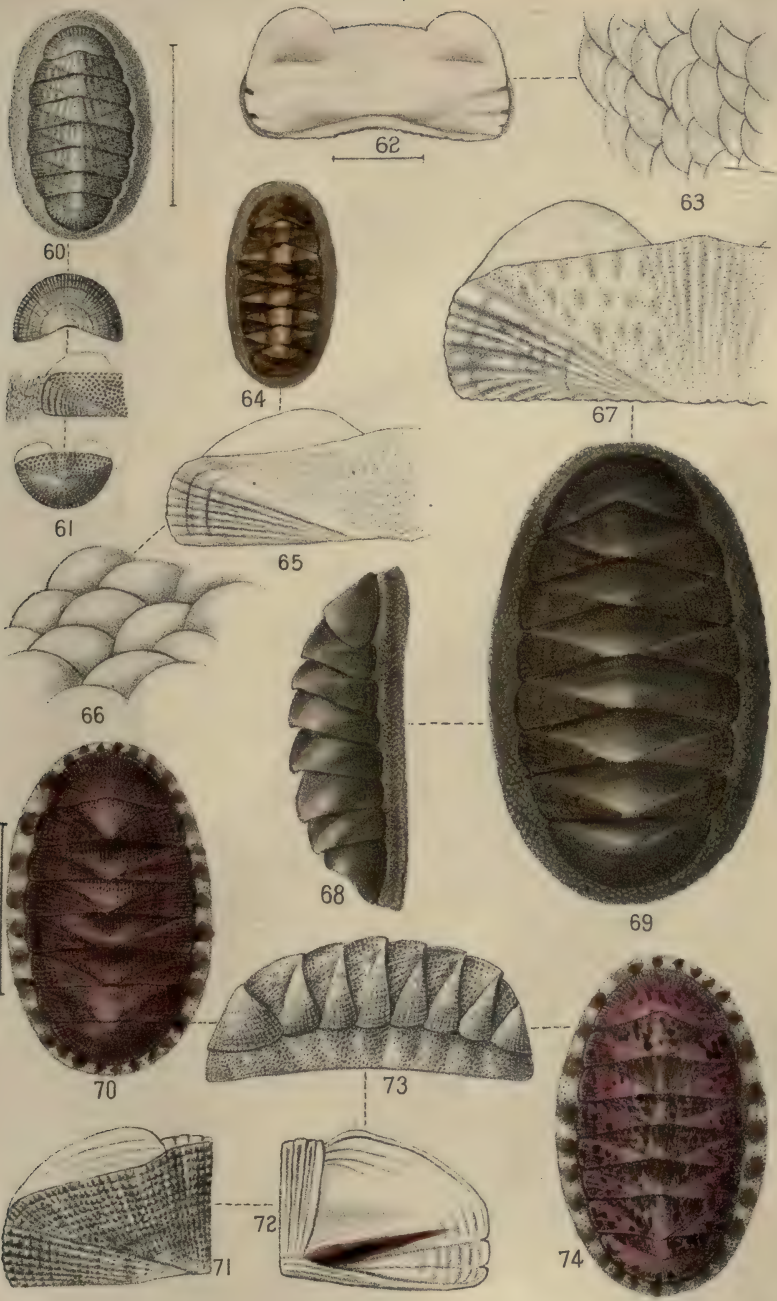
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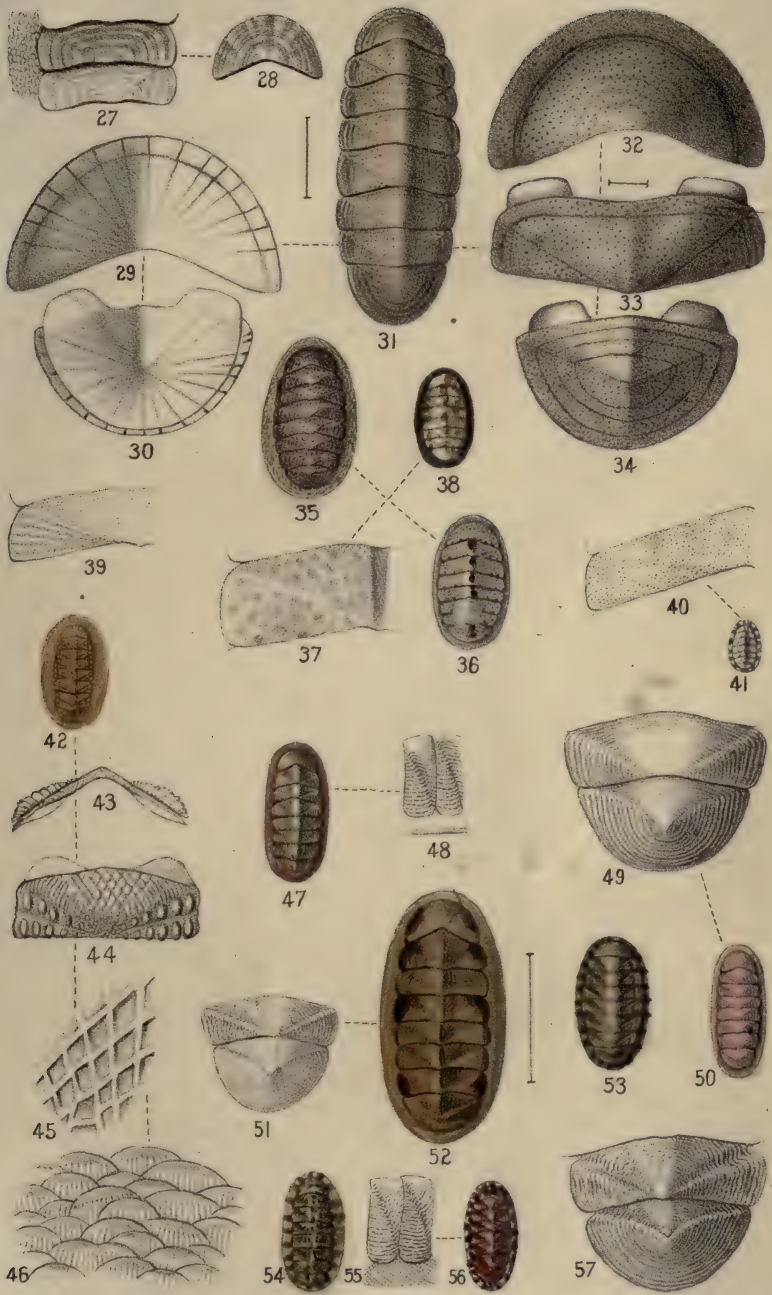
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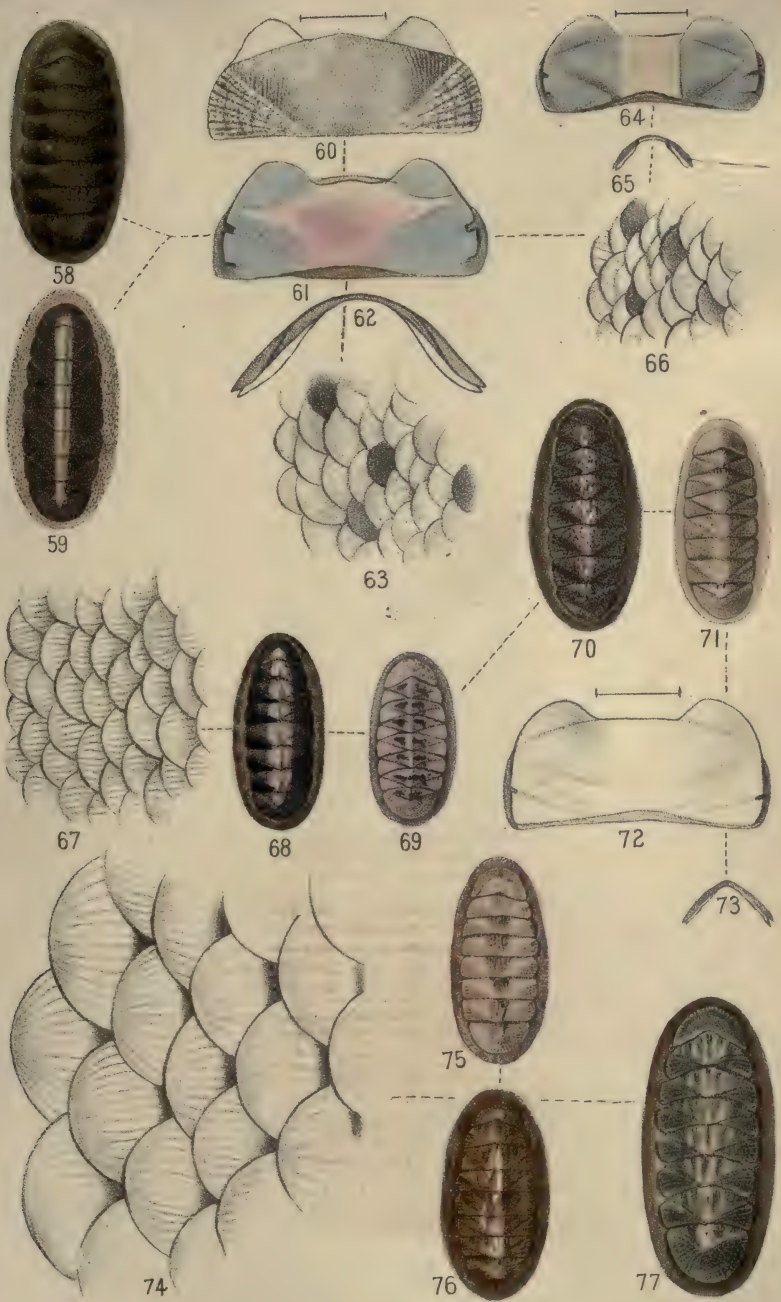
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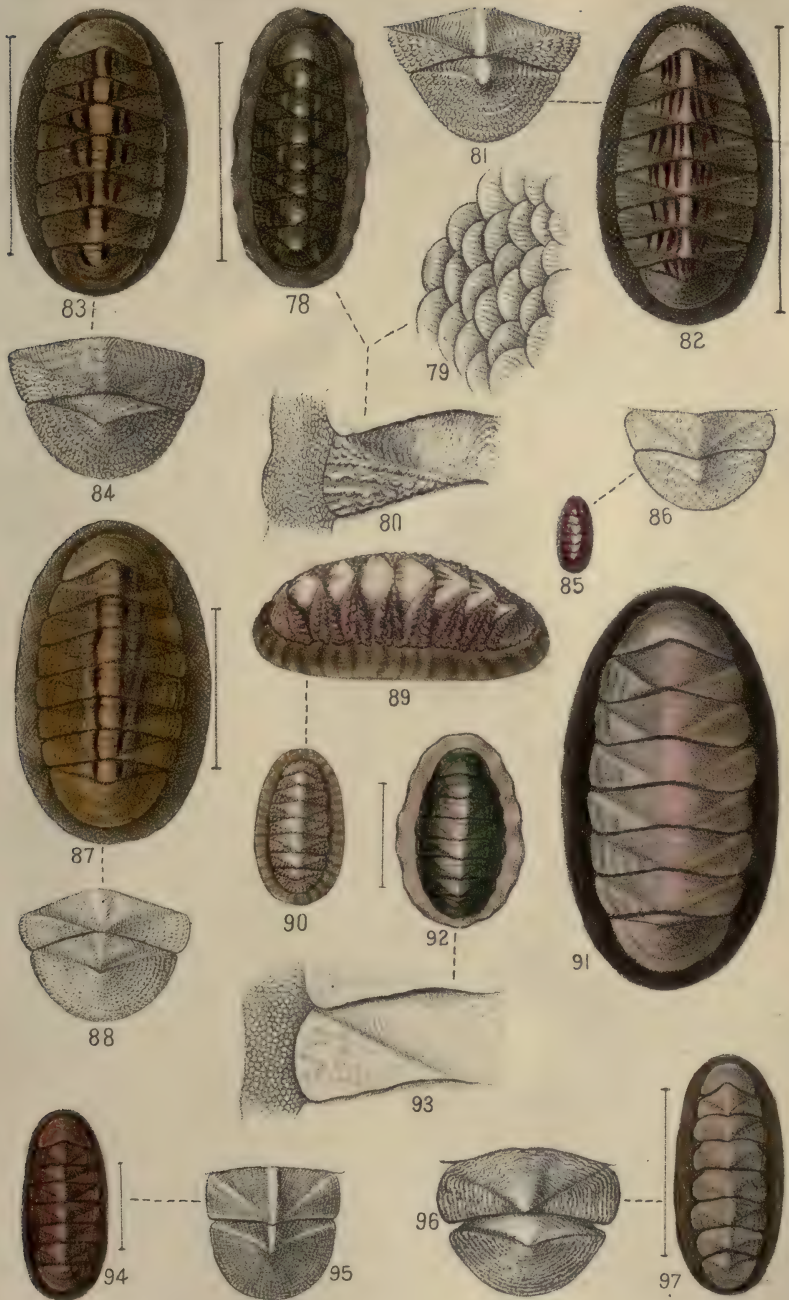
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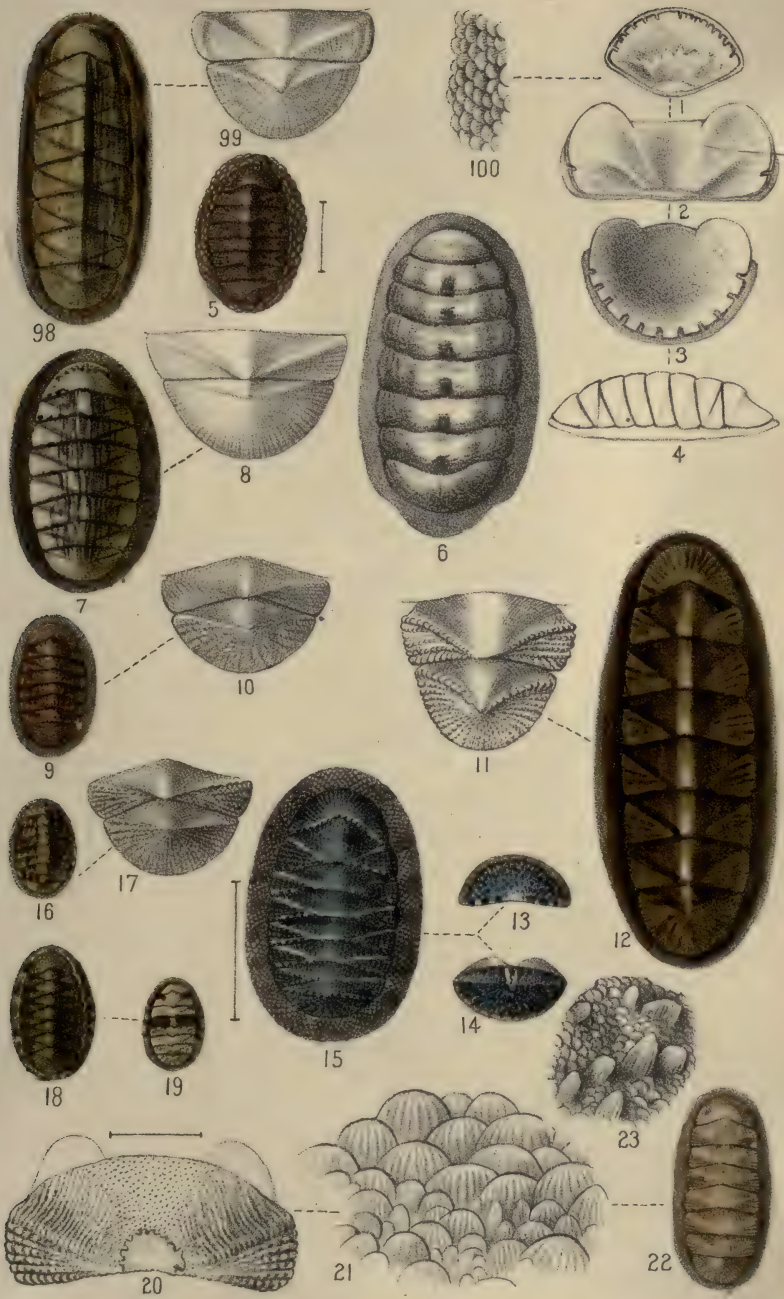
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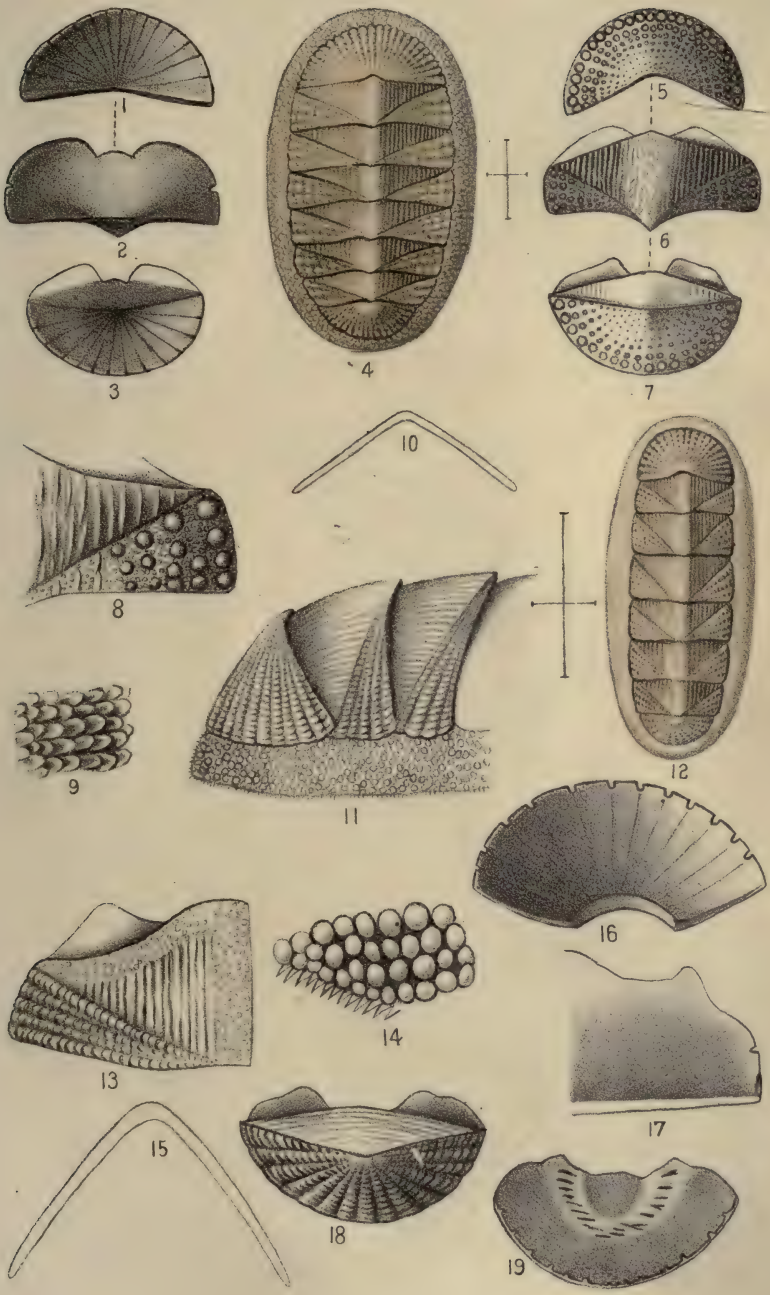
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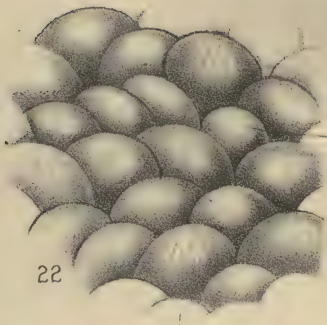
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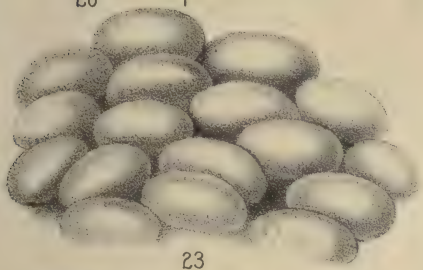
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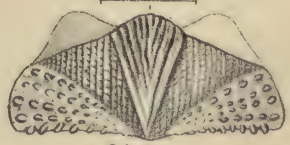
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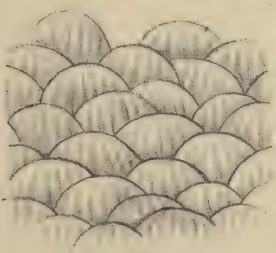
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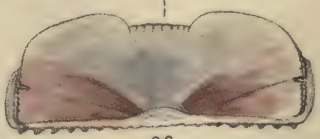
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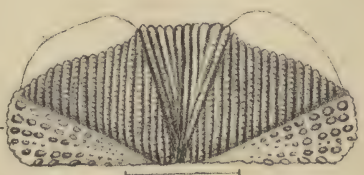
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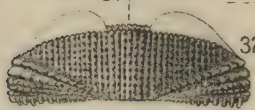
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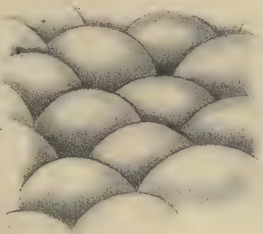

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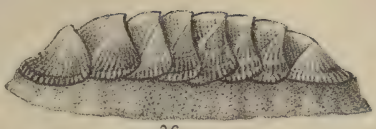
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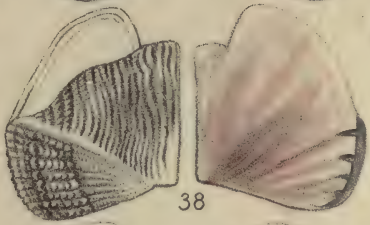
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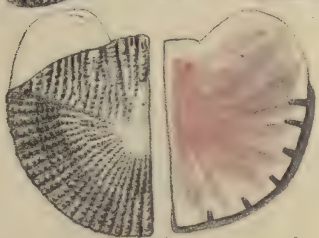
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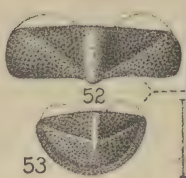
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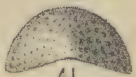
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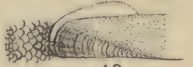
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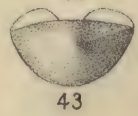
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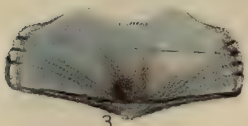
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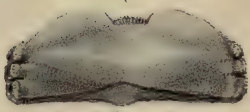
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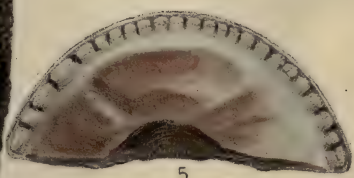
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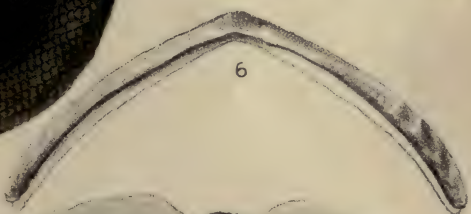
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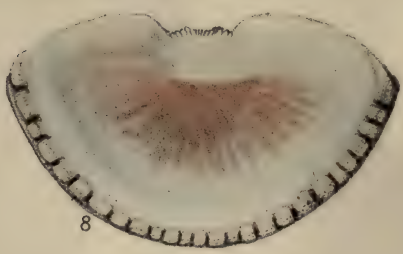
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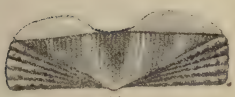

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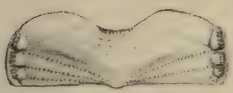

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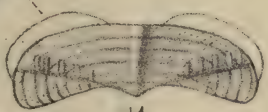

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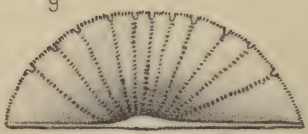

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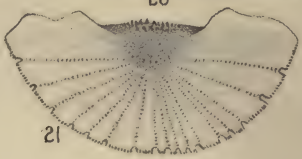

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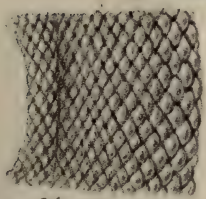

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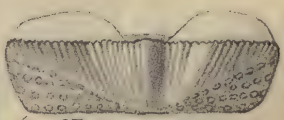

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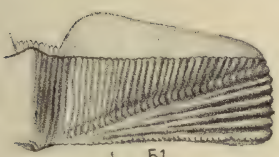

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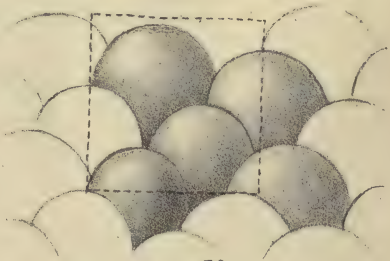

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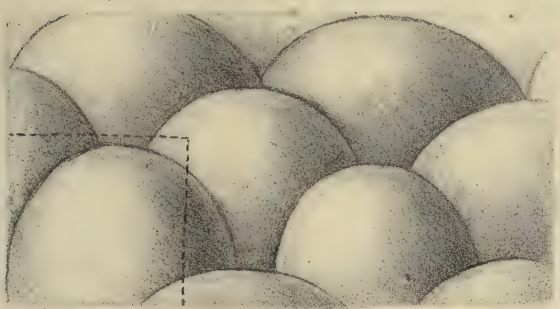

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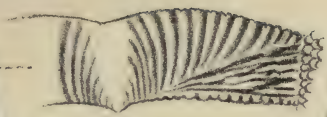

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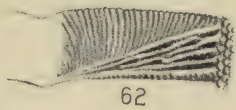

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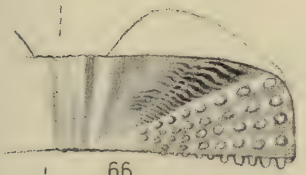

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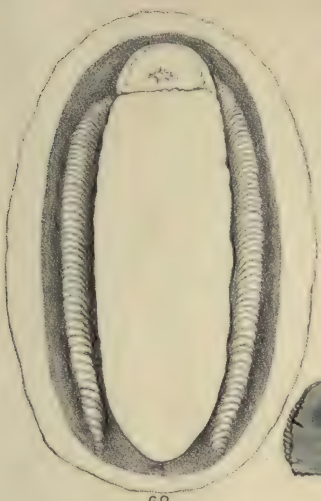
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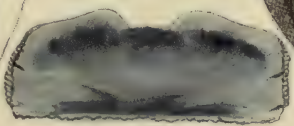
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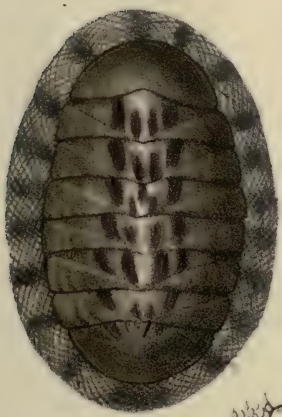
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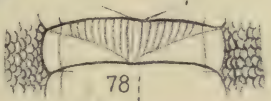
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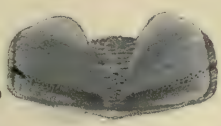
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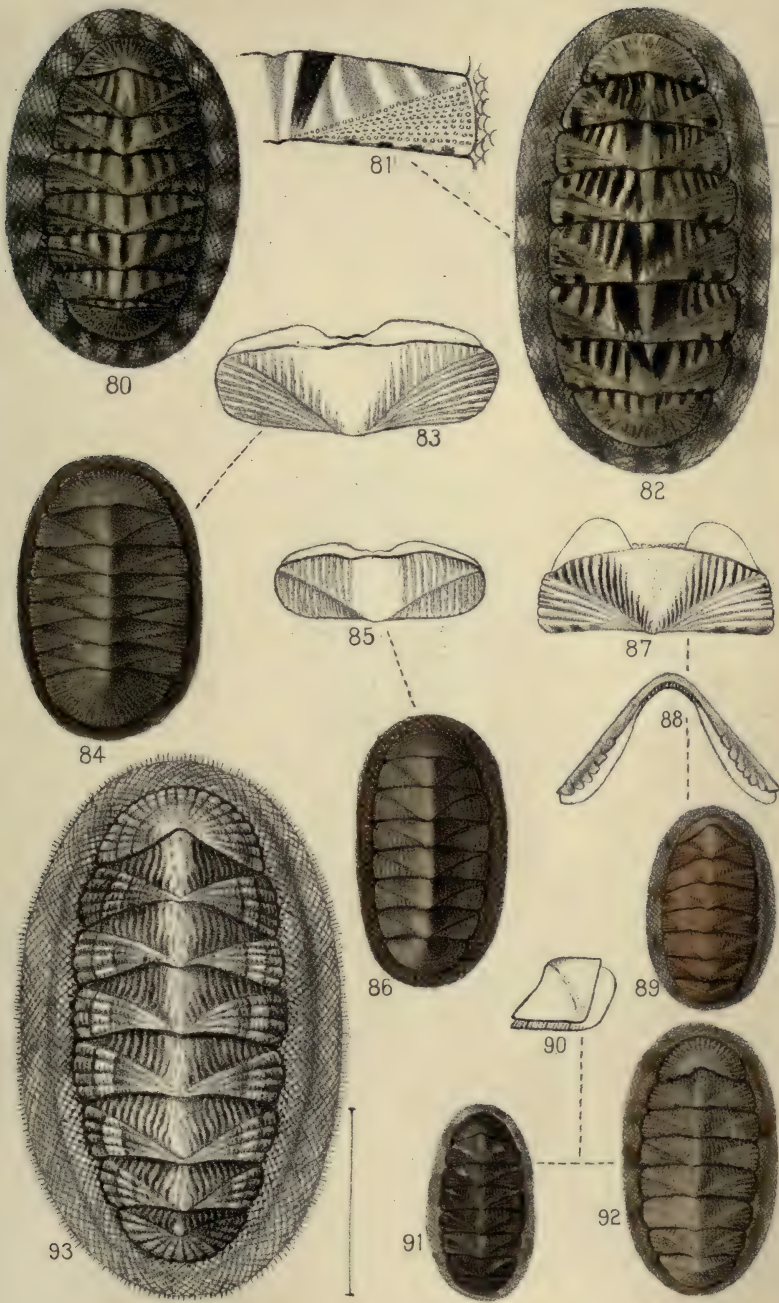
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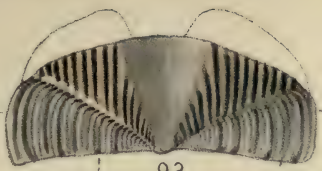
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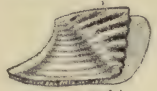
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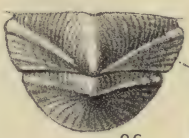
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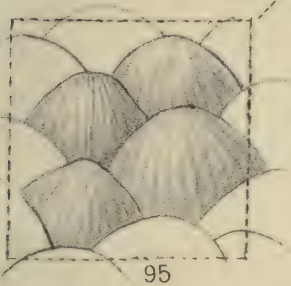
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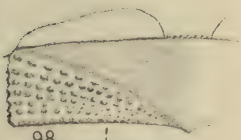
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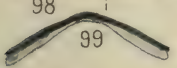
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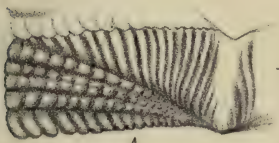
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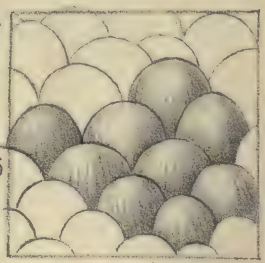
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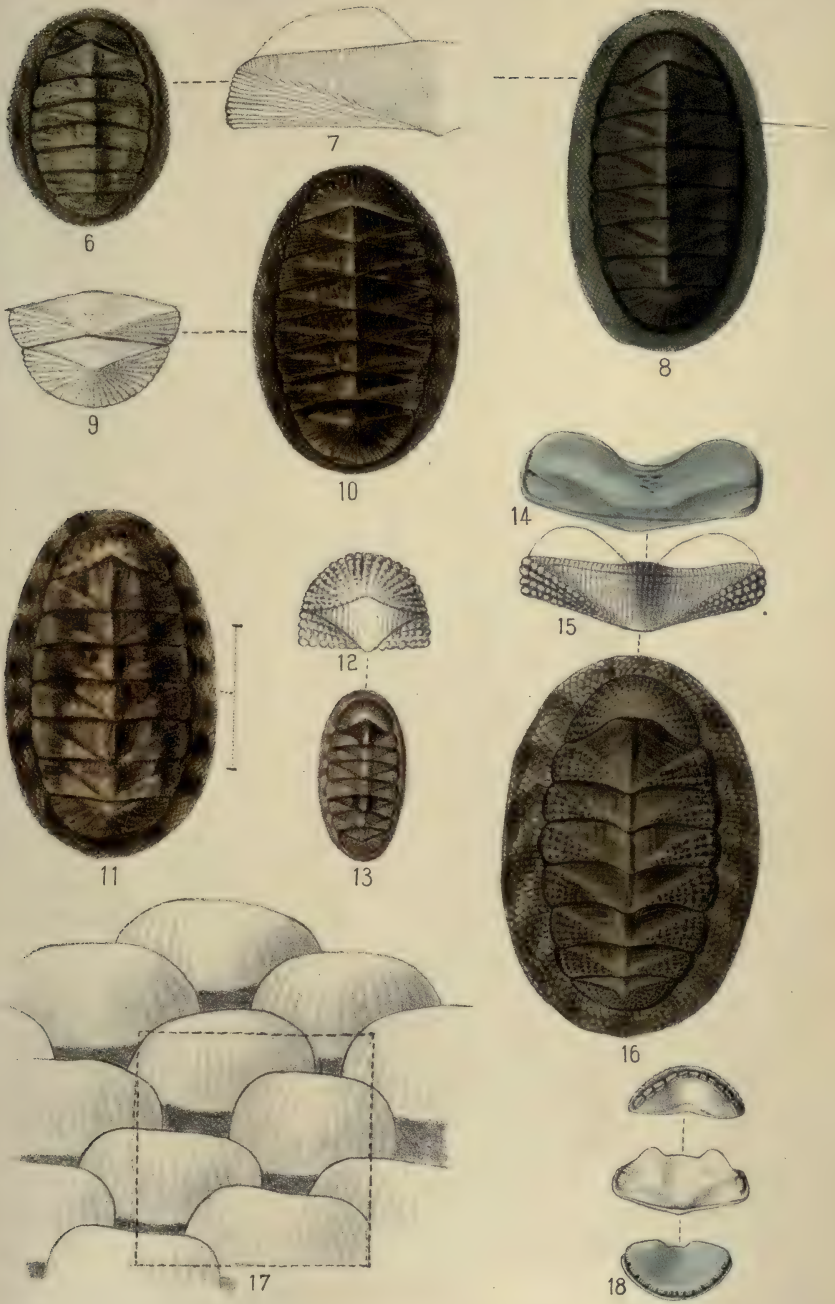
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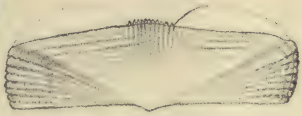
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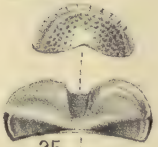
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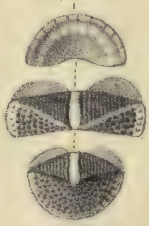
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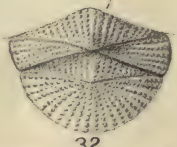
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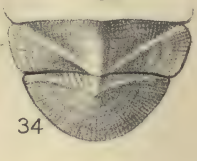
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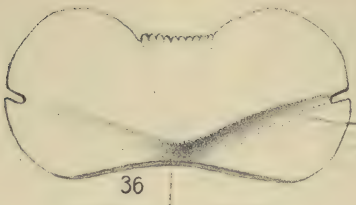

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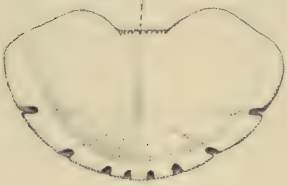

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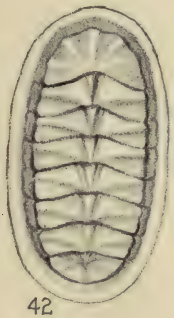

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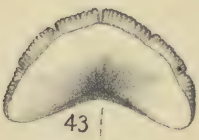

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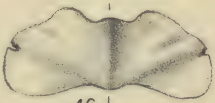

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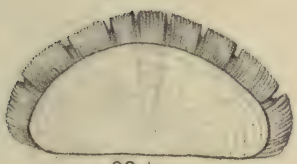

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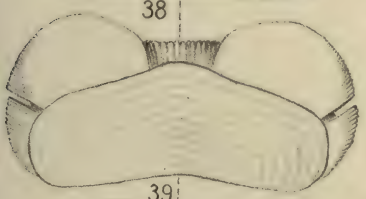

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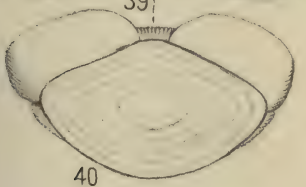

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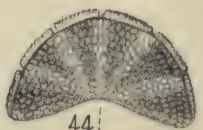

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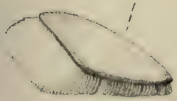

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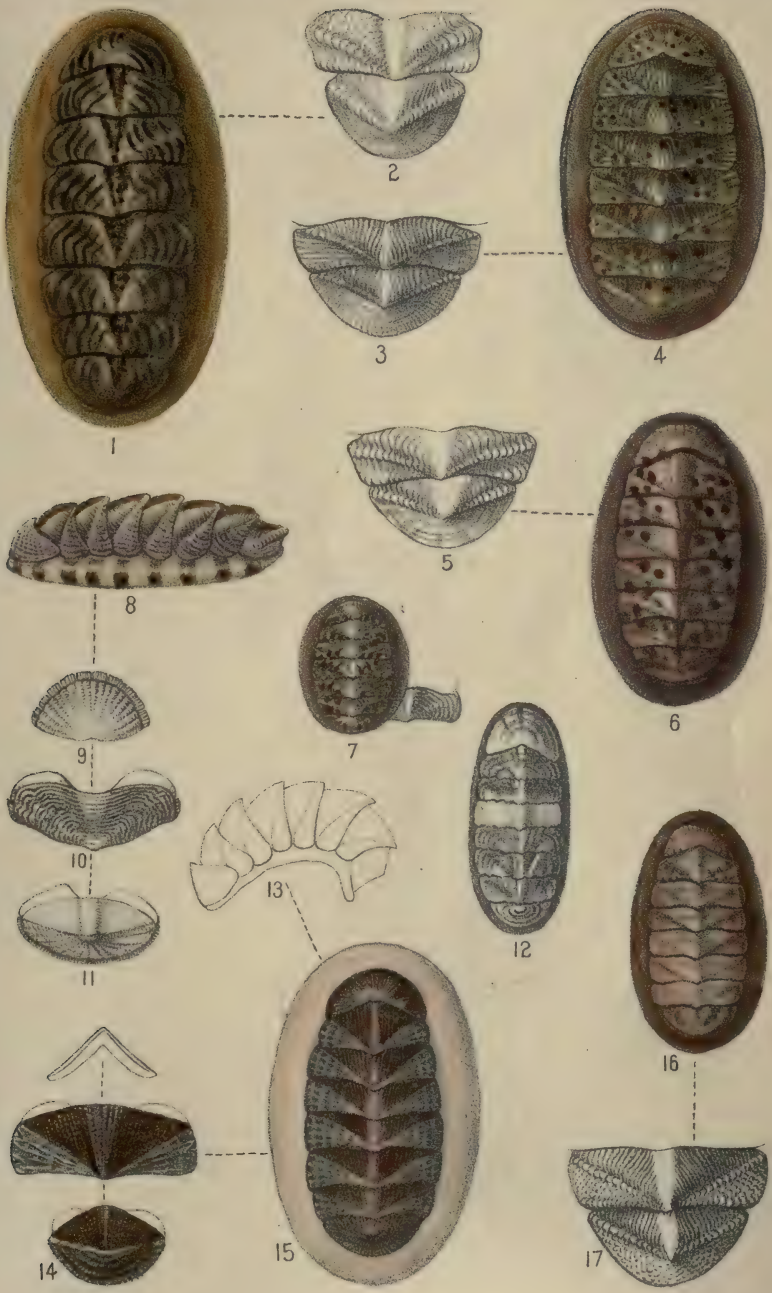
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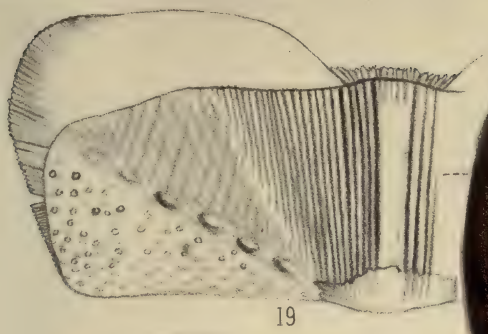
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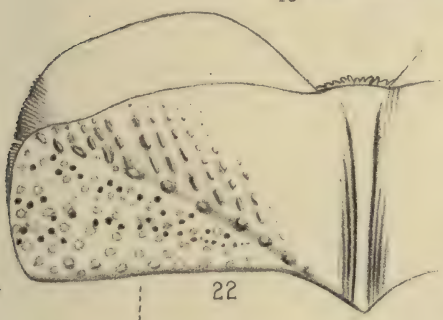
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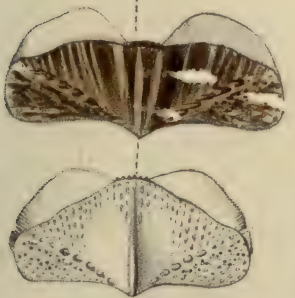
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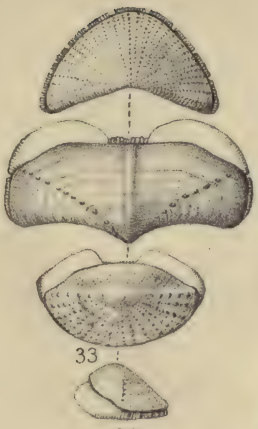

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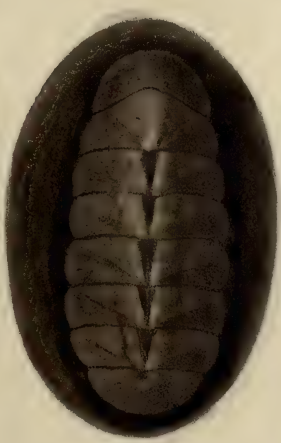

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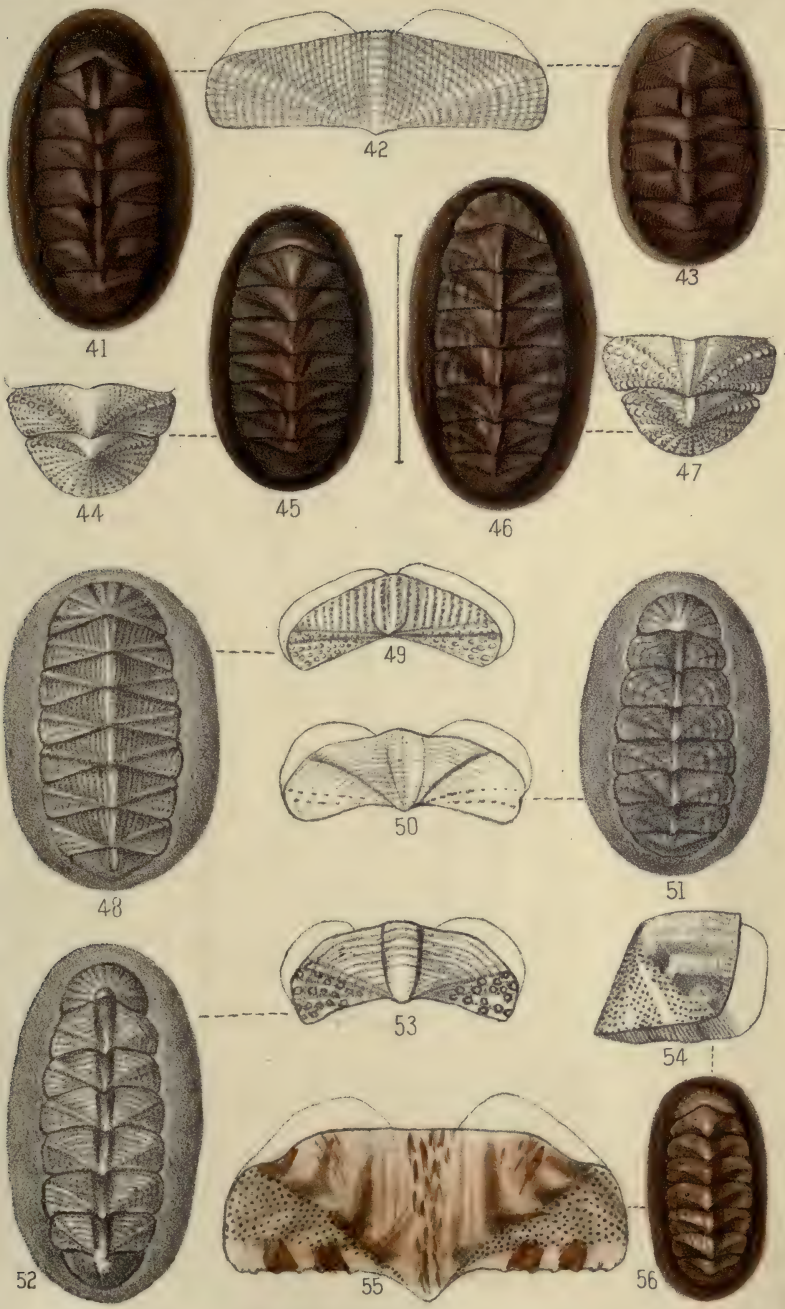
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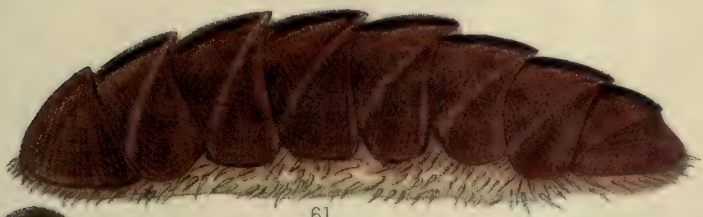
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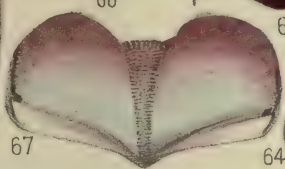
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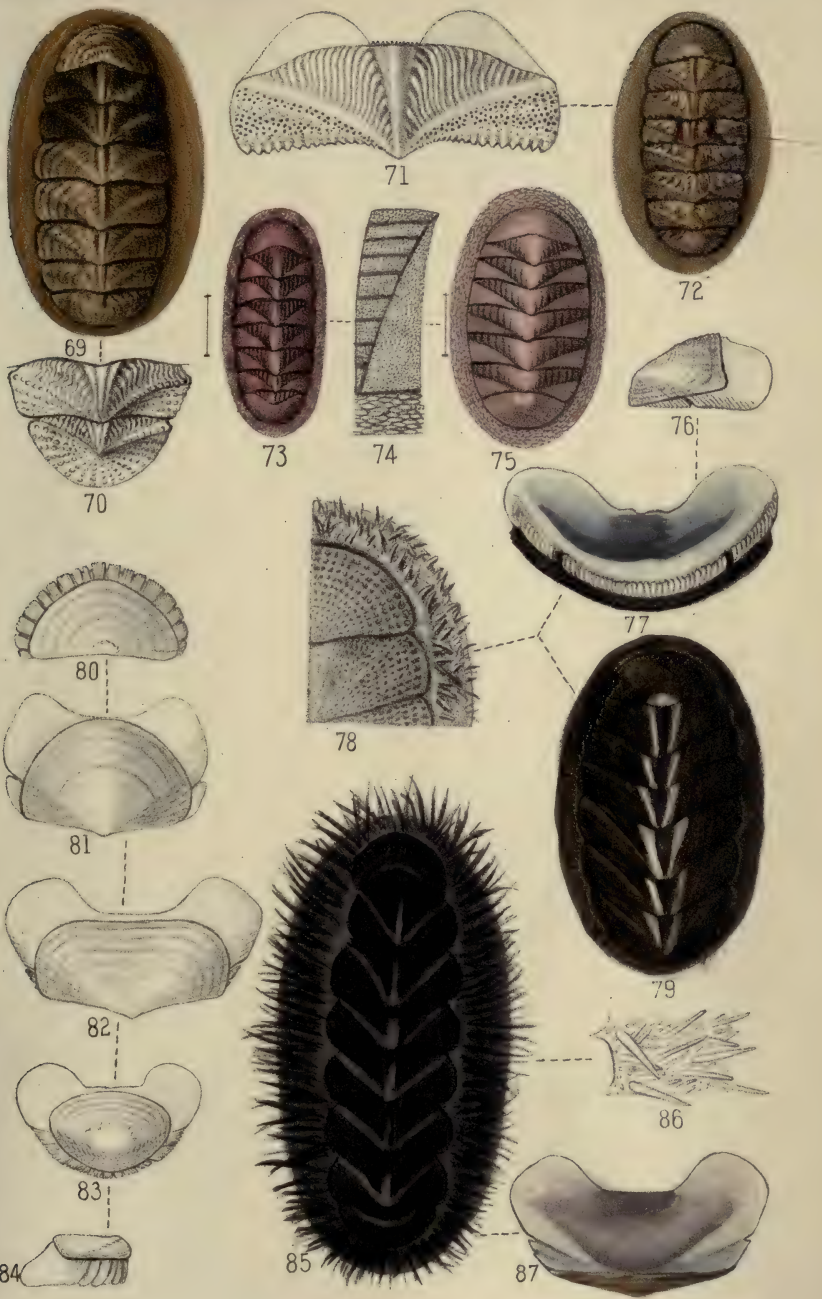
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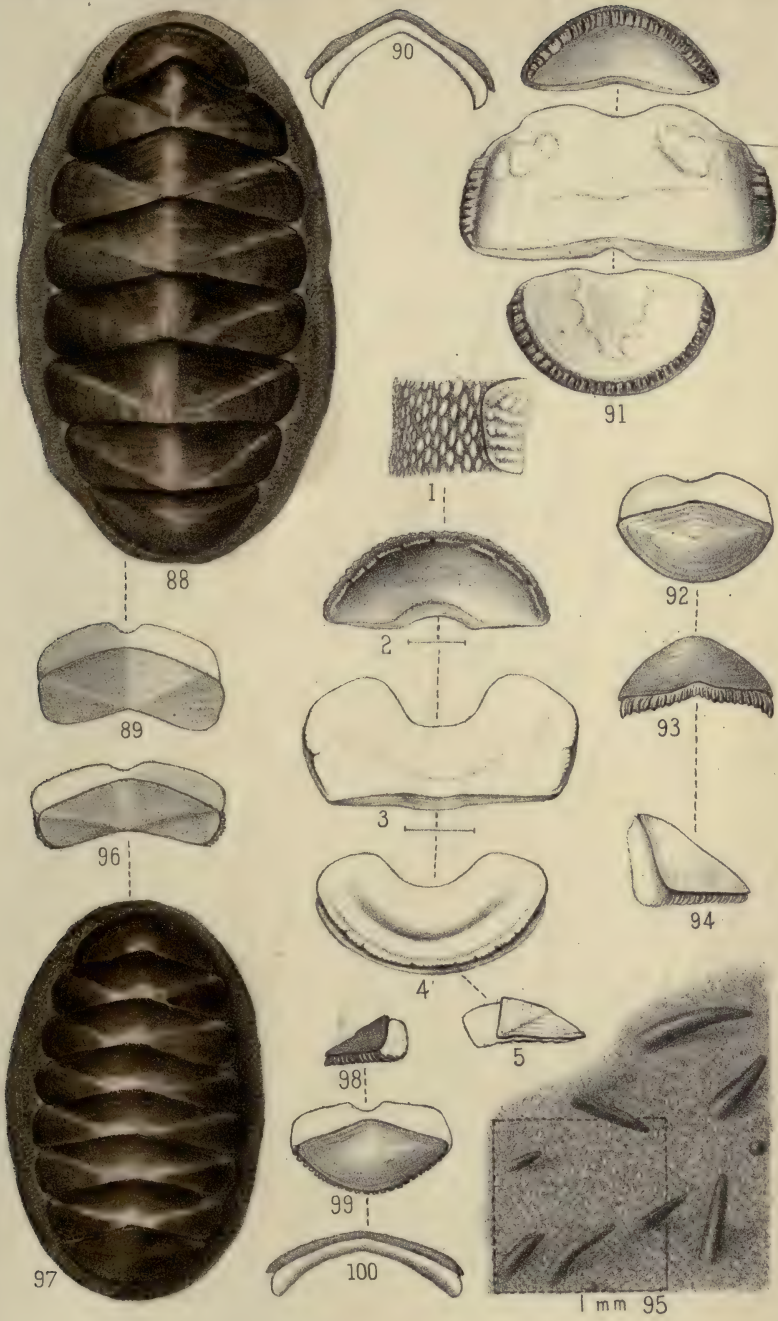
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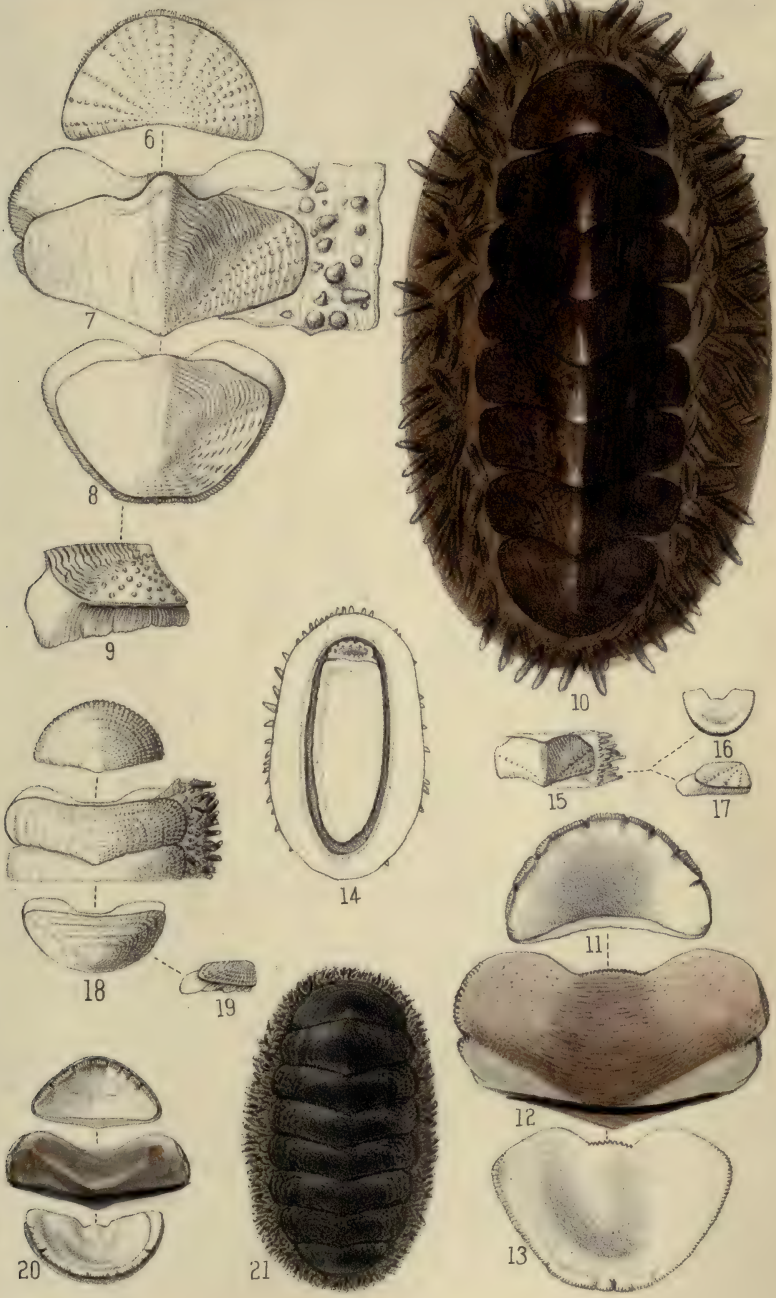
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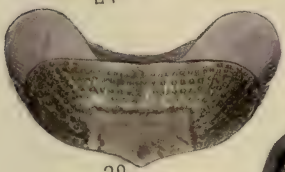
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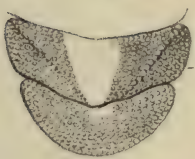
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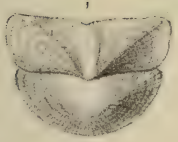

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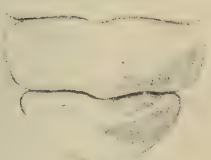

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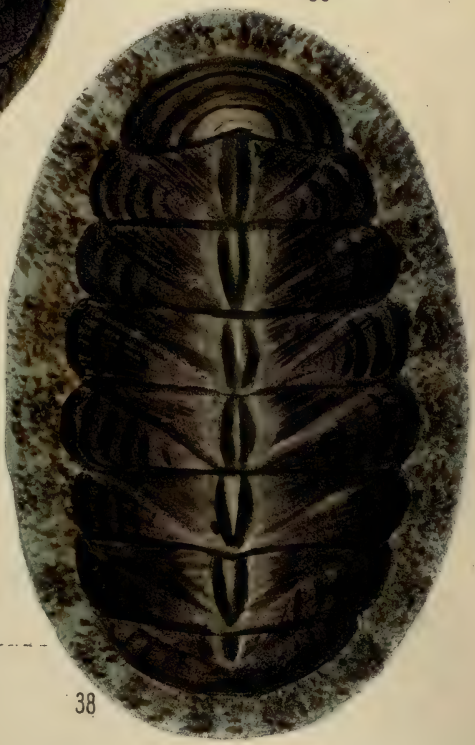

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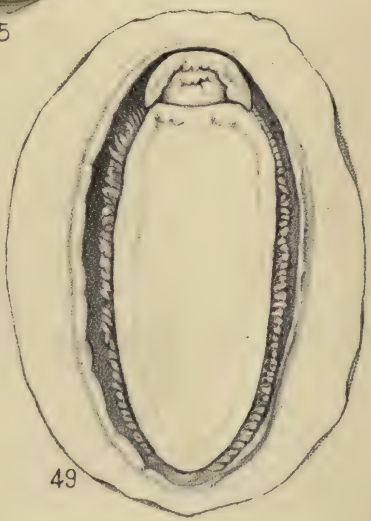

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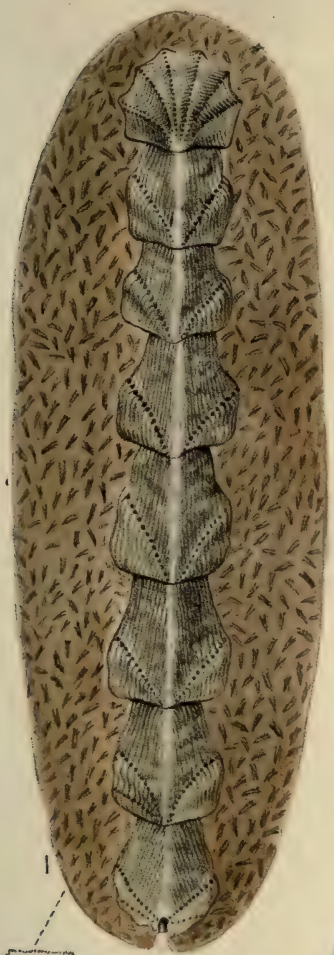
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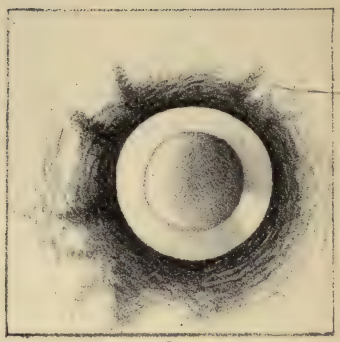
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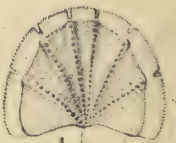
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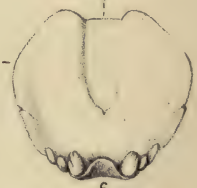
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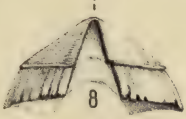
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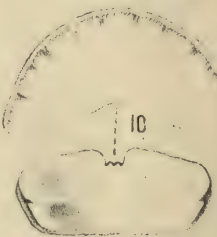
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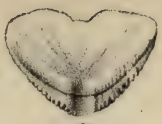
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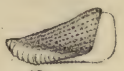
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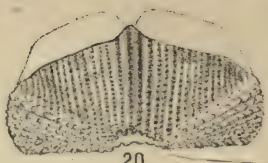
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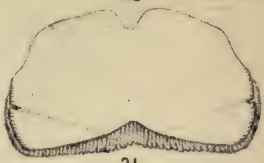
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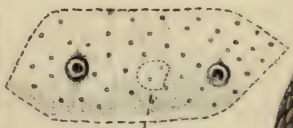
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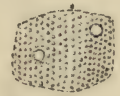
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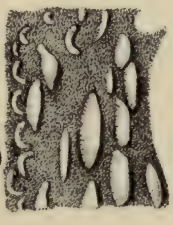
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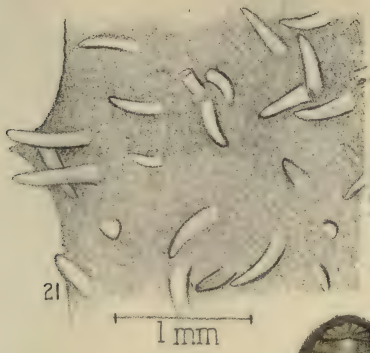
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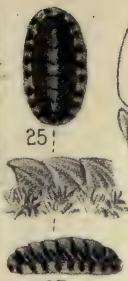
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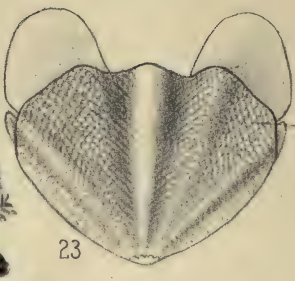
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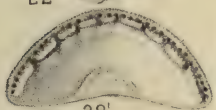
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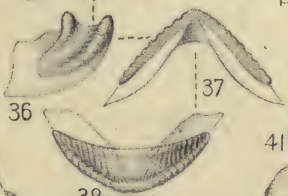
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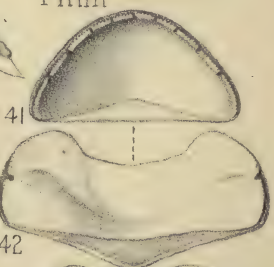
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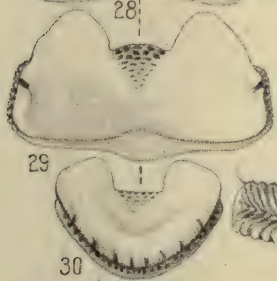
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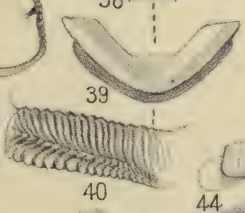
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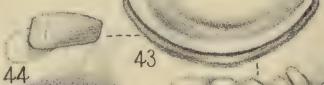
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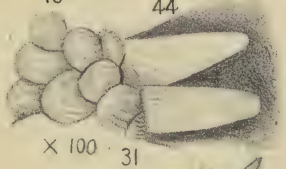
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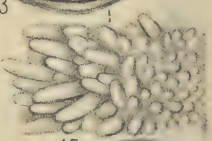
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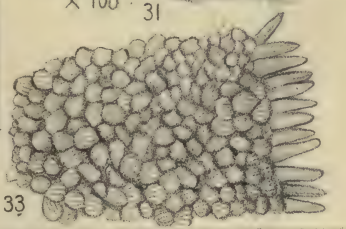
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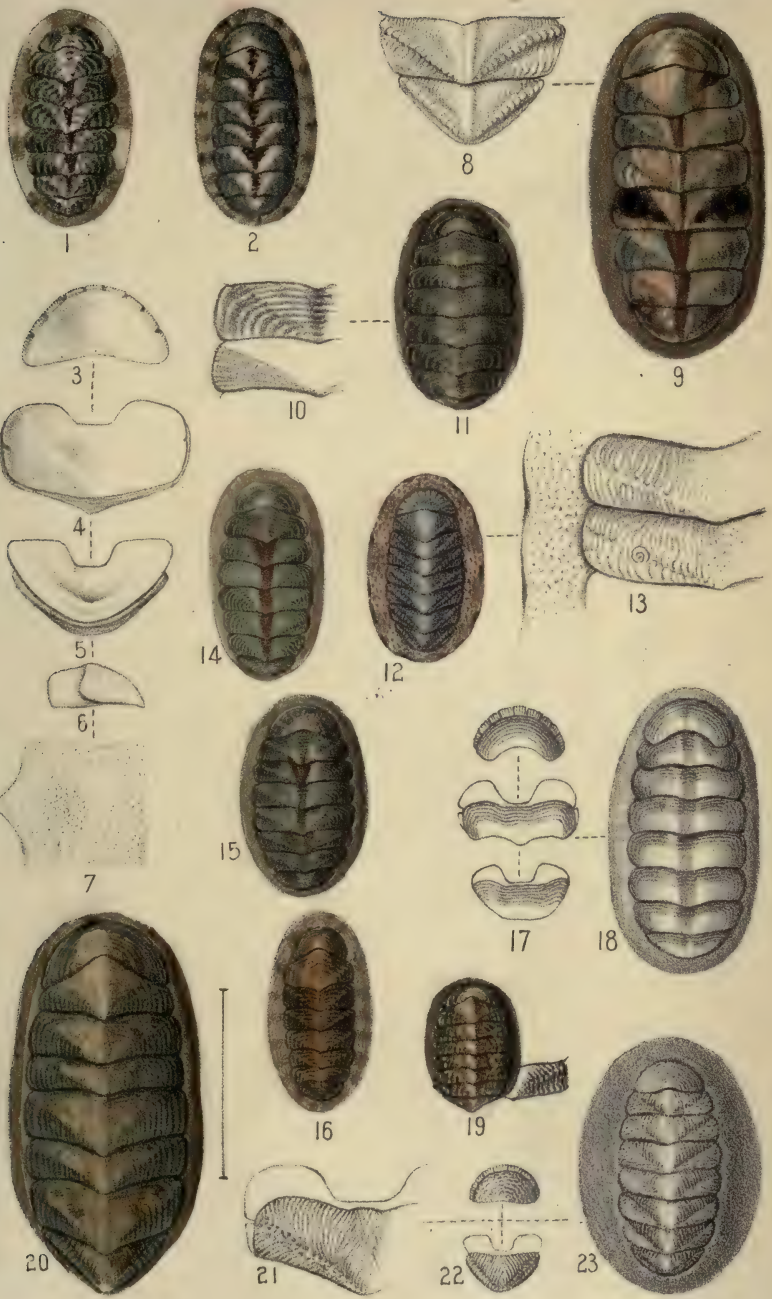
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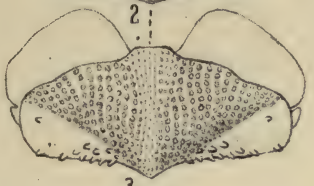
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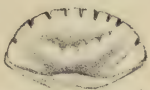
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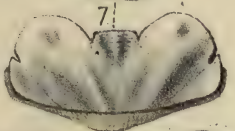
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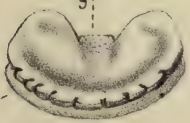
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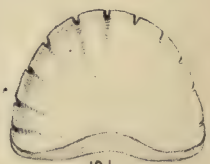
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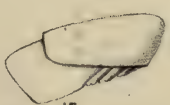
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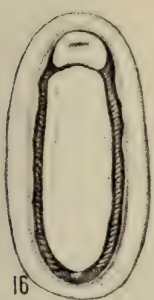
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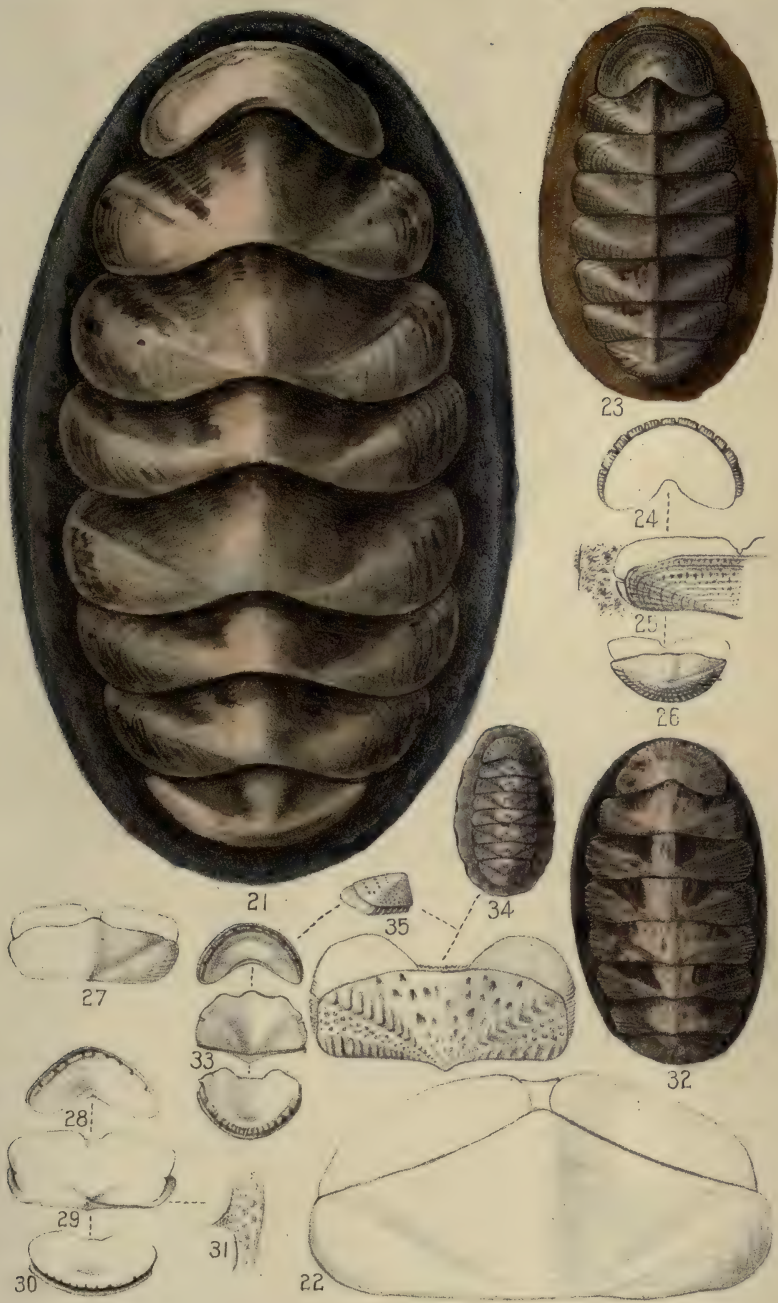
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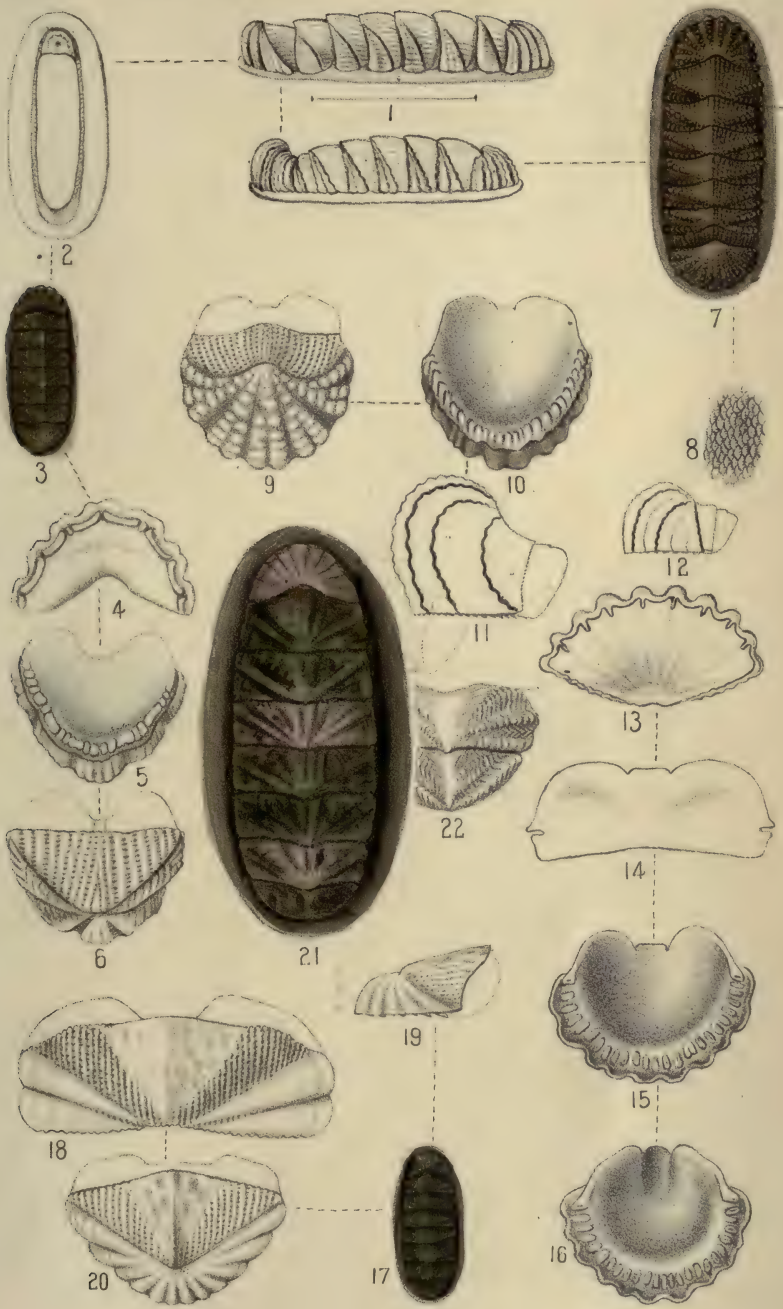
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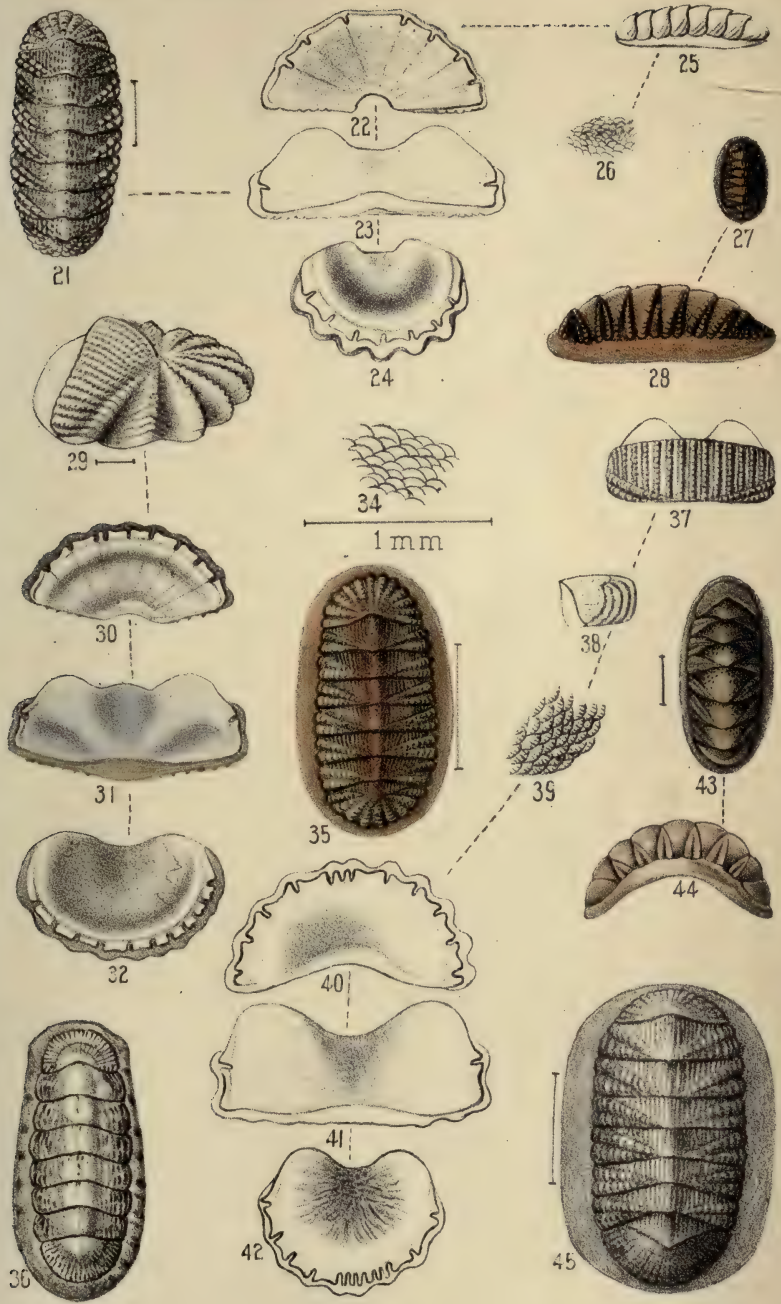
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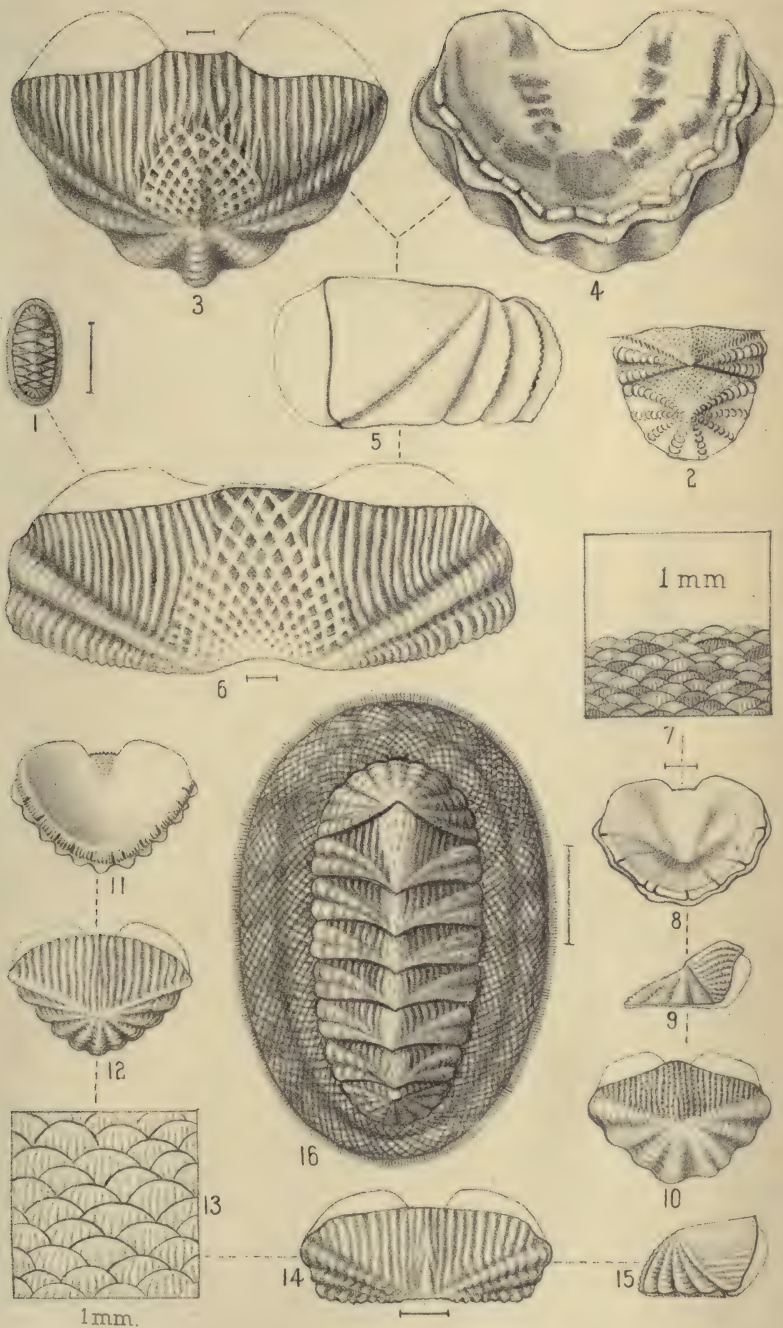
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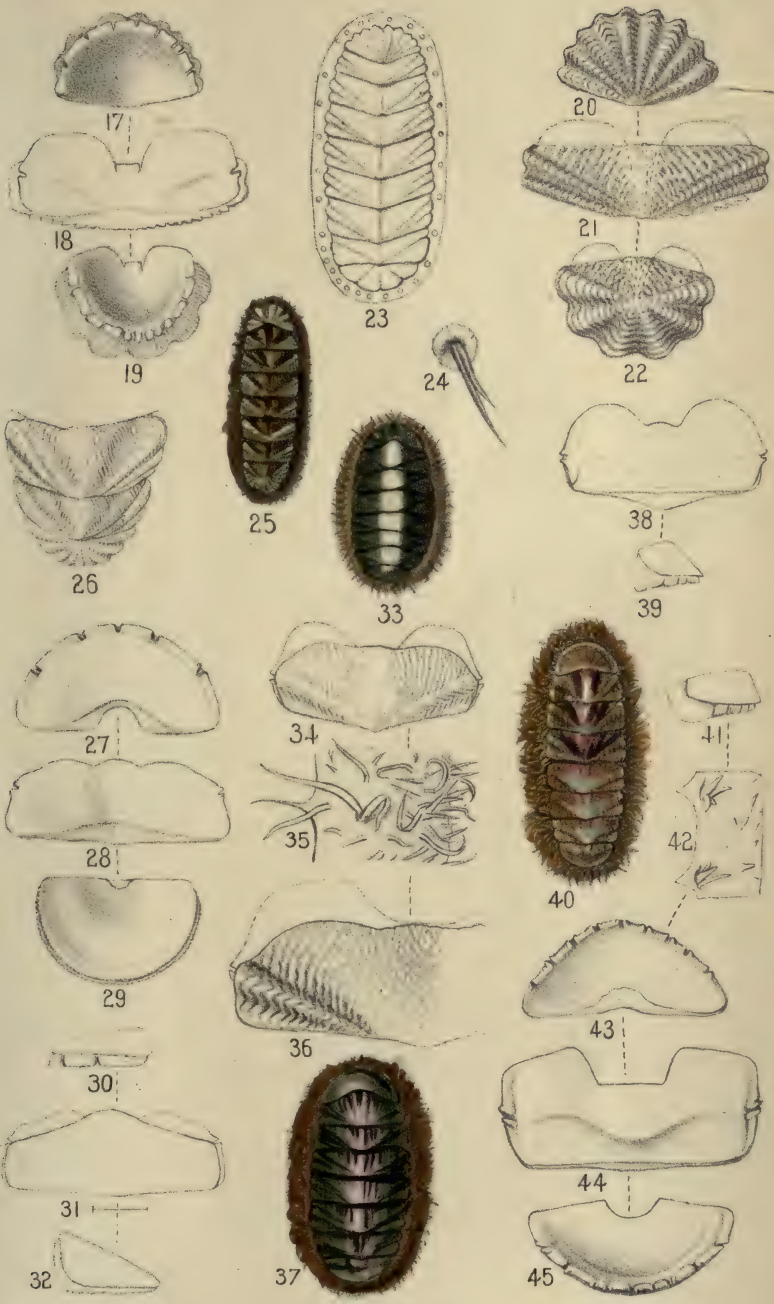
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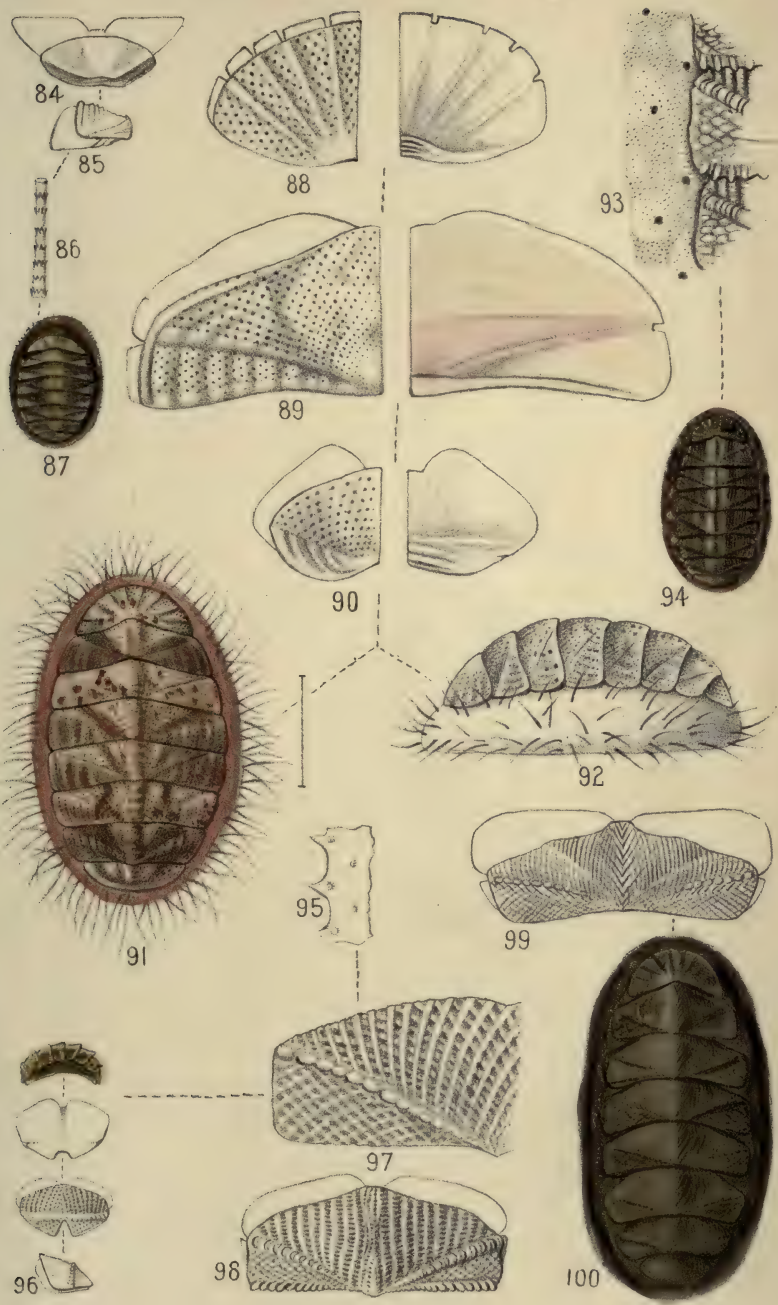
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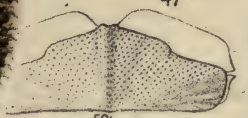
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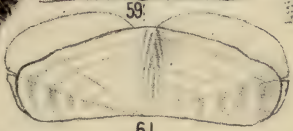
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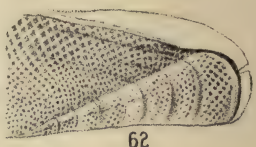
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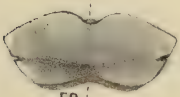
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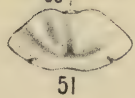
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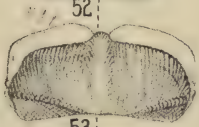
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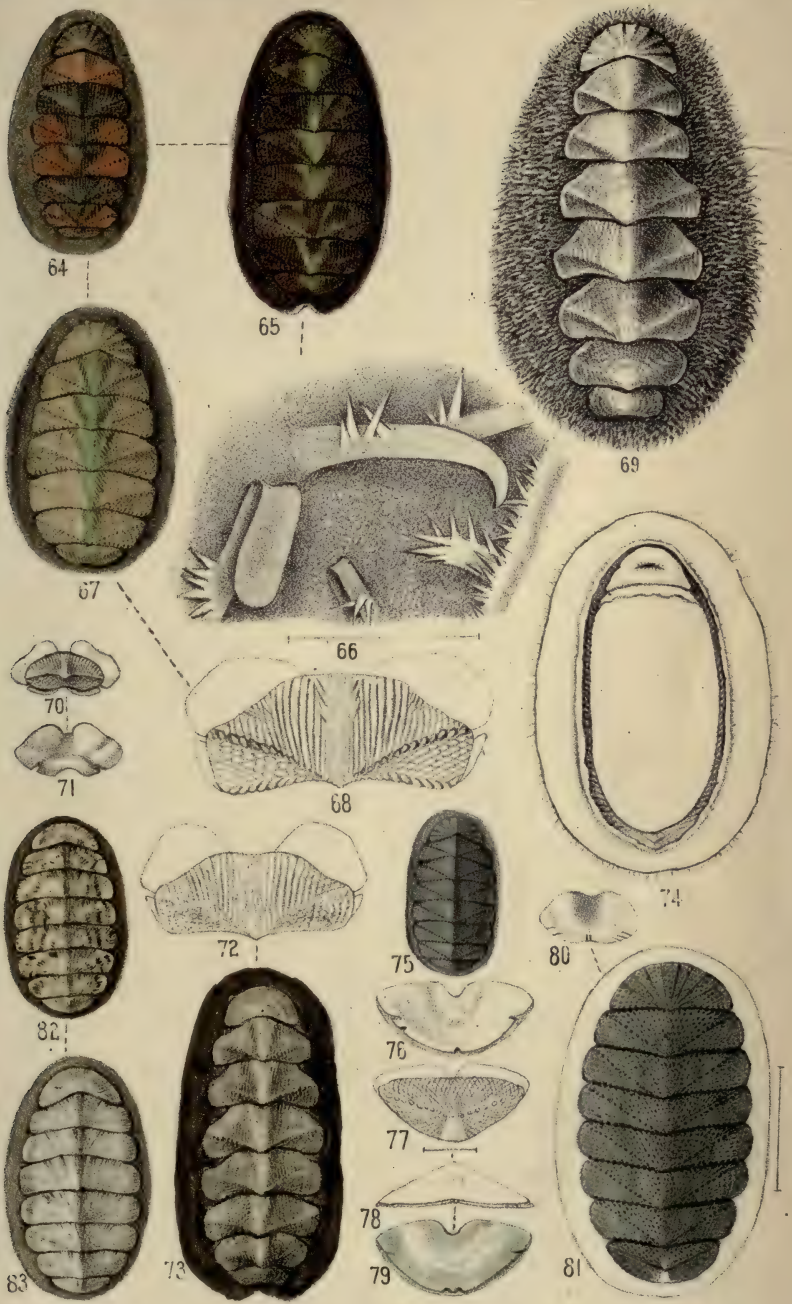
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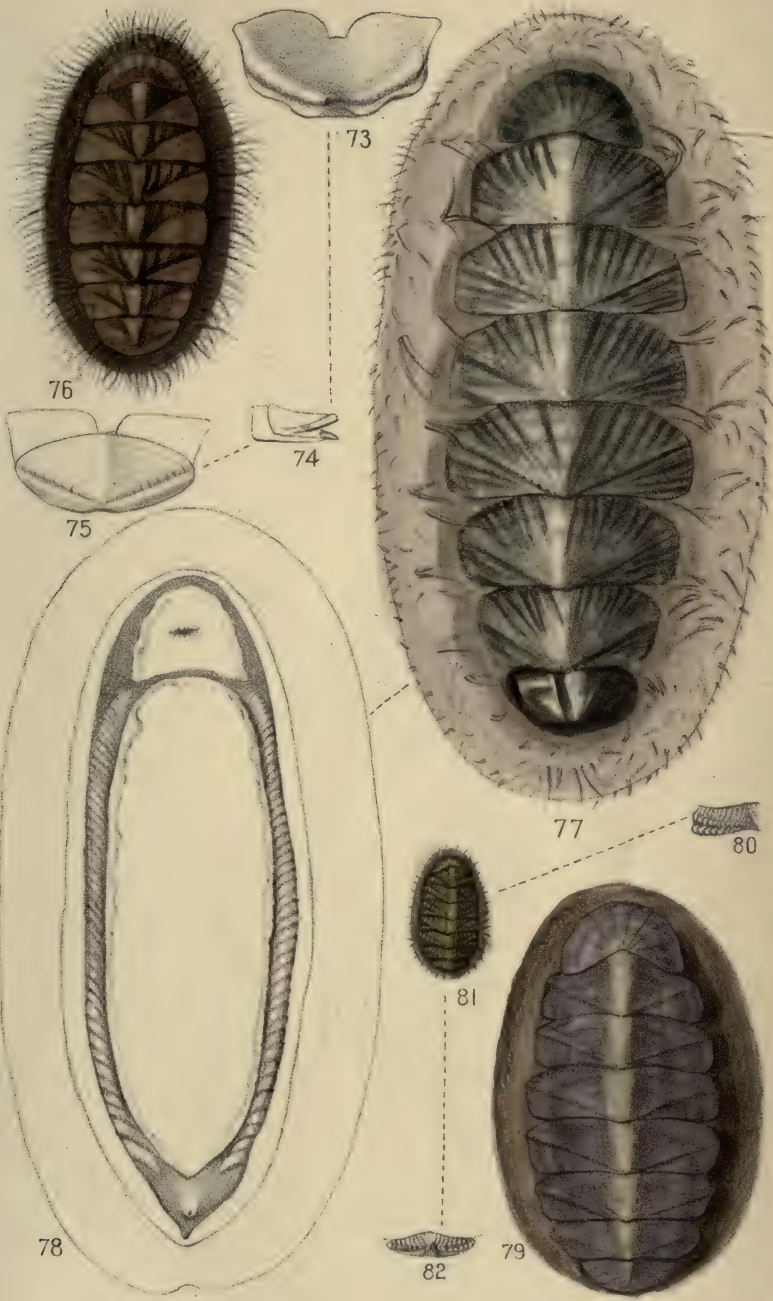
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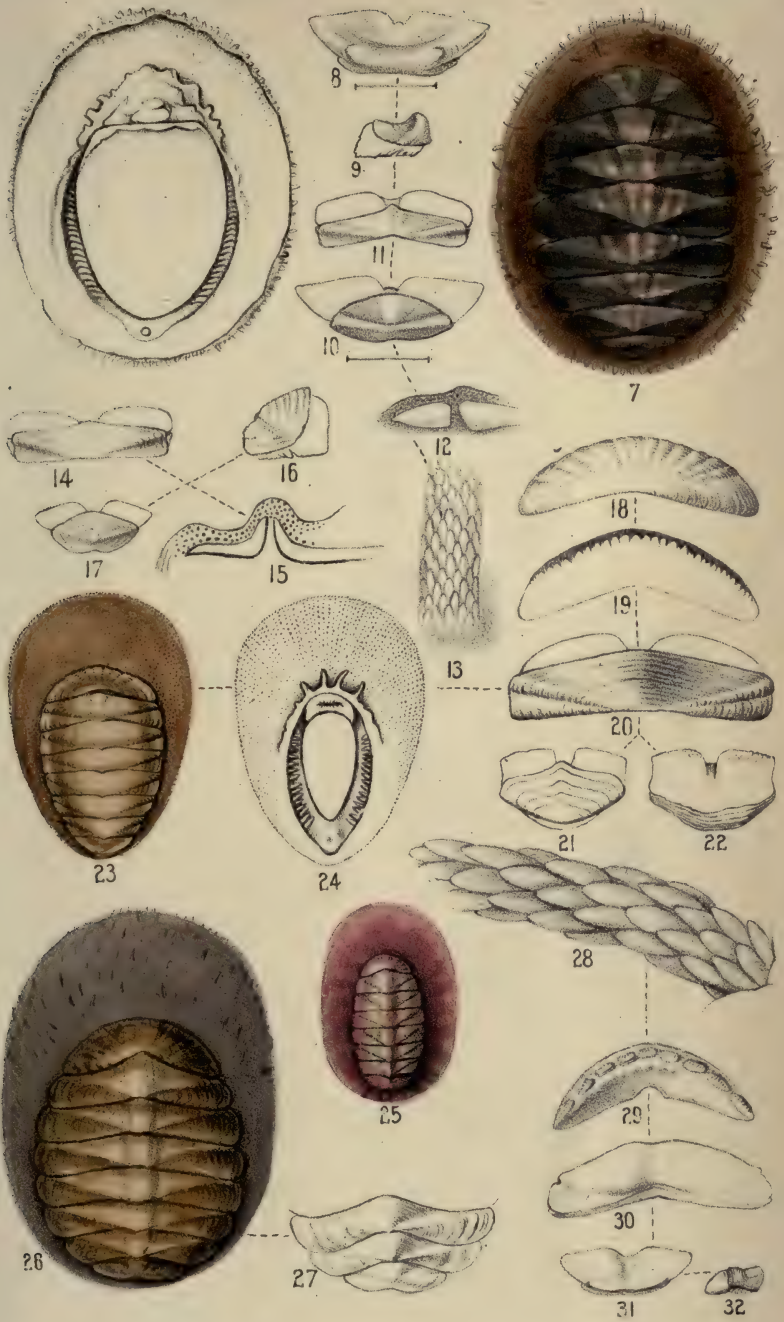
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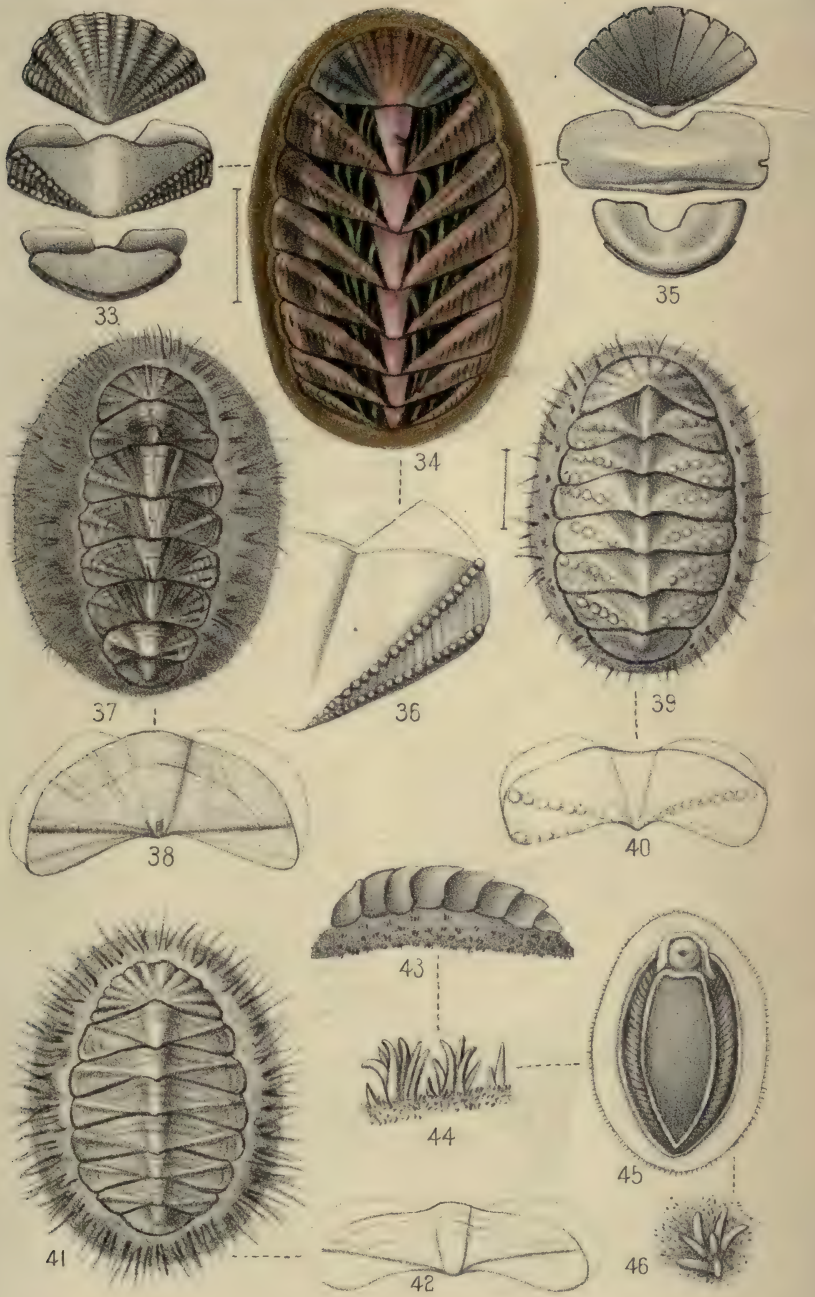
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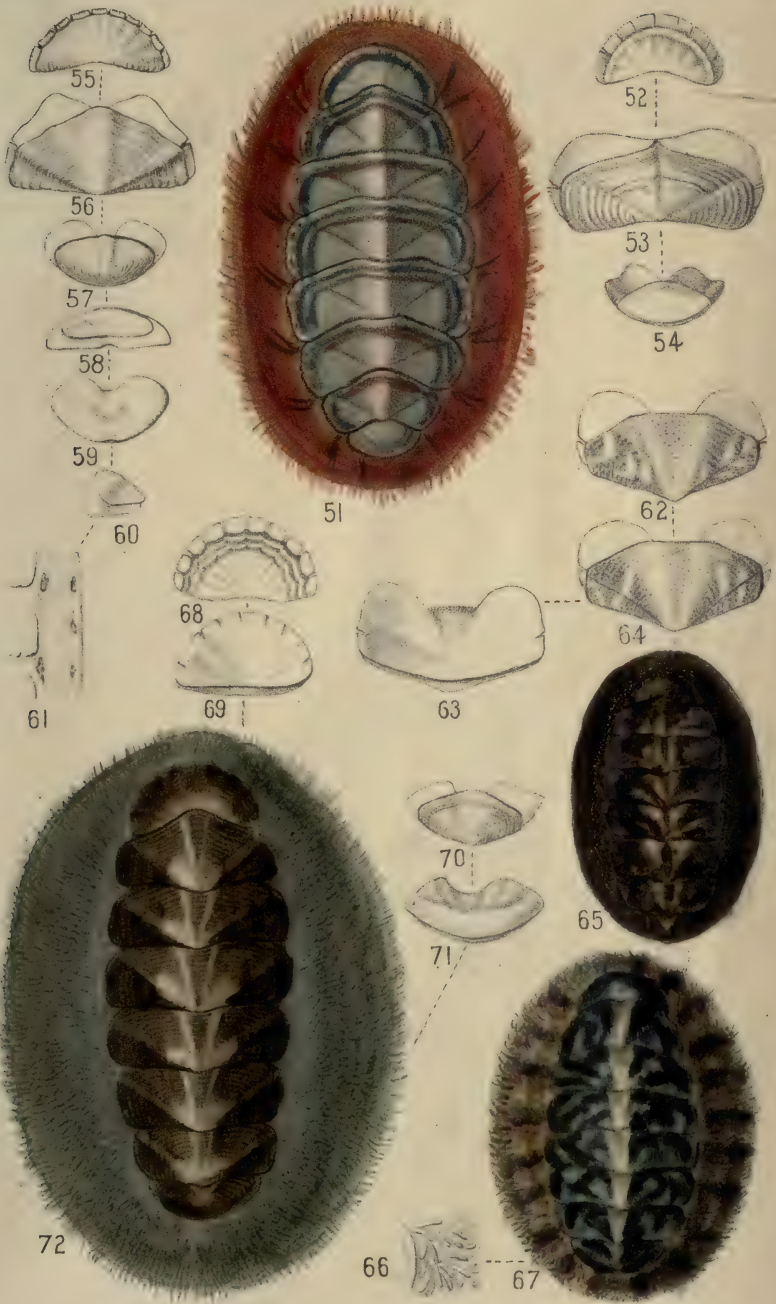
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